

Hidden Topology of Life: Life and Space

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Abstract:

Taking into account a variety of contemporary definitions of life, I propose to focus on relations between complex systems of life processes and the evolution of our perception and concepts of space. My investigations are closely connected with a series of artistic projects under the common title *The Hidden Topology of Being* which are realized in cooperation with science research centers both in India and Poland. In this short presentation I do not concentrate to a great degree on the description of my artistic works but on questions of how science, humanities and cultural imageries influence each other and combine in shaping our understanding and knowledge; and how technology modulates these relations.

Key words: art & science, space, life, spatial thinking, multidimensionality, biomolecules, biosystems

Our perception and understanding of the phenomenon of life has been changing drastically in recent decades. Aristotle's concept of life, which prevailed in the humanistic tradition for over two thousand years, was based on the notion of a living organism. Since we acknowledged that life "happens" on the molecular level this view has lost its dominant position, giving way to other avenues of approach. Many scientists claim that only DNA is „alive" and what we used to perceive as a "living organism" is merely a part of the much larger habitat of a replicating gene. The essential feature of a gene is that it contains information about its close environment and causes this information to be stored and transmitted. Thus life processes are often identified with processing (preserving / transmitting / exchanging) information.

Furthermore, the Encyclopedia Britannica focuses more on thermodynamic than genetic issues.

Following Carl Sagan, it states that a living formation is a distinguished part of space in which, due to the energy flow, entropy decreases periodically. The second law of thermodynamics secures the balance between highly organized living processes and the increasing entropy of the Universe.

Another interpretation of biological processes is associated with the so called "life imprint": a spatio-temporal pattern in the physical environment indicating some highly organized activities which we could recognize as life.

All these definitions are interconnected and refer in one way or another to space.

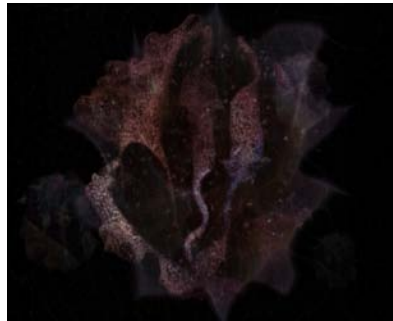


Fig.1. "Hidden Topology of Being" still from the video-animation.
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I found inspiration for my artistic investigation in S.Semotiuk's philosophical deliberations at the conference "Space in Contemporary Science"[1]. From Semotiuk's perspective, life can be perceived as a mode of existence of space and, vice versa, space can be treated as a mode of existence of life. This tautological definition not only implies the understanding of a "unit of life" (or an "individual existence") as an integral fragment of its physical environment, but also locates its parameters at the heart of the rich history of human culture, based on the diversity and evolution of our spatio-temporal conception of reality.

In this paper, I would like to share my reflections on the relations between life and space; questioning how science, humanities and cultural imageries influence each other in shaping our perception and knowledge, and how technology modulates these connections.

My inquiries are strongly linked to my long-term project *The Hidden Topology*

of Being {fig.1.} which embraces a series of multimedia works realized with the support of research centers in India and Poland: the International Centre for Genetic Engineering and Biotechnology in New Delhi, the CEMA Centre for Experimental Media Art and the National Centre for Biological Sciences in Bangalore, as well as the Genesilico Laboratory of Bioinformatics and Protein Engineering, and the International Institute of Molecular and Cell Biology in Warsaw [2].

Spatial thinking

When we scrutinize the history of the European comprehension of space and time, we can easily notice that it has been by no means homogenous. In fact the passion for "spatialization" can be seen as islands in the kingdom of *Chronos*. The group of "geometrizing" philosophers like Pythagoras, Parmenides, Zeno from Elea, Plato or Euclid prevailed for only a few centuries (VI-III B.C.). Then the interest in space diminished because priority was given to human and cosmic existence in time. Even in art, the invention of perspective appeared quite late and after only a couple of centuries renaissance techniques of creating illusions of "depth" began to lose their importance.

It was only Johannes Kepler who publicly opposed the domination of *Chronos*, stating: „Credo spatioso nomen in orbe". His viewpoint was supported by Galileo, Descartes, Newton and others, proving connections between "spatial thinking" and advances in science. In biology for example, the idea of a torsional space of animated matter, introduced by J.W.Goethe and followed by L.Pasteur, led to the discovery of the double helix of DNA. Chemistry developed crystallography and a single atom became a "scroll of space" using John A. Wheeler's term [3]. Even regularities like Fibonacci numbers, revealed in many natural forms, turned out to be the indication of overlapping spatial spirals in opposite directions.

Looking from today's perspective, it seems that the last century brought the ultimate victory of space over time. Mathematical intuitions of C.Gauss, L.Lobaczewsky, H.Minkowski or E.Lorenz were soon satisfied by Albert Einstein's discovery of united and

relative space-time. Time became just one more spatial dimension in the multidimensional nature of our reality.

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In modern culture, time also lost its dominant character. Focused on the future, the avant-garde treated it as a territory that ought to be conquered and colonized; a space that one can volitionally shape. This attitude has been continued and reflected in many fields of human activities from space programs to nanotechnology and genetic engineering.

Anthropomorphic nexus: scales & dimensions

Looking from the biological perspective, the space of every species can be defined by its anatomy, its environment and activities based on its morpho-physiology. In the case of the human being, the technological space gives extra-morphological means to reach spaces beyond direct sensual experiences. It influences strongly what can be truly named as “human space”: the ratio of a given/inherited space to a constructed one. Their dynamics are clearly uneven and we are subjected to the incessant clashes of these two spaces. Then, the expansion of the constructed space dooms us to the effort of the constant translation of its micro and macro scales into the mezzo scale of our direct experiences and imagination.

By nature, each of us feels and comprehends any space from the center of their own space. Thus we cannot entirely avoid the anthropomorphism of space and the perceiving of ourselves as a nexus where all scales and dimensions interact and merge.

The Hidden Topology of Being – Proteios

Searching for a key to the investigation of this nexus through my art, I went to India, to the International Centre for Genetic Engineering and Biotechnology in New Delhi, where my fascination with the protein molecule began. This “basic brick of life” is made of elementary constituents of cosmic matter: mainly of carbon, oxygen, hydrogen and nitrogen. As we can imagine, their journey from the nuclei of stars to our bodies was extremely long and complex. In its latter part, each carbon atom was photosynthesised by a plant; each oxygen atom was part of an

ocean. Our bodies share not only genetic information (coding our proteins) but also environmental information.

There is some optimism in the fact that at the atomic level, inscribed in the cosmic recycling system, we are practically immortal. Even an atomic arrangement of a protein (revealed by treating its crystallised form with X-Rays) can be easily mistaken for a fraction of the starry sky. Yet, it does not hide stories about our gods and ambitions but sequences of amino acids. An unexplainable readiness of nature to connect these short monomers, suggested by the Miller-Urey experiment as well as by the analysis of meteorites, supports both hypotheses of a biogenesis and panspermia.

Still, an amino acid sequence (the primary structure) says very little about the complexity of the unique topology of a folded protein. The amount of dimensions needed to describe its conformation (tertiary or quaternary structures) equals “3Dⁿ” where “n” is the number of atoms. This is far beyond the capabilities of our minds to envision. I was already enchanted by the geometrical beauty of the secondary structure, with its folding alpha helixes, beta sheets and turns. They reminded me of the mysterious geometric formations named Calabi-Yau spaces in which, according to the superstring theory, successive dimensions of our world are “curled up” on the subatomic level. I found not only formal resemblances, but also similarities in their evolvment: from a point (an atom) into a linear narrative (a chain of amino acids) shaping bending and twisting surfaces into complicated spatial structures of interactions.



Fig.2. “Proteios”, still from the 3D video-animation.
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In a video animation “Proteios”, a fragment of cosmic space folded into a Calabi-Yau form giving rise to a folded molecule of protein, in a poetic way alluding to the complexity of our realm. If the scientific hypothesis about the multi-dimensional nature of the world is true, then Calabi-Yau spaces are everywhere, in each “point” of the space outside as well as inside us. {fig.2}

One day, maybe, our brain will be able to perceive how we exist in the multidimensional universe or even multiverse. For the time being, we have only our imagination in command and an enormous diversity of protein globules, each of them suggesting, in a different scale, a blister of some world. {fig.3}



Fig.3. “Hidden Topology of Being”, still from the 3 video-animation.
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Post-Pythagorean dreams

The more we expand the borders of our cognition the more we discover relations between micro and macro structures of our universe.

The holistic attitude is not a new one but it acquires a new reading of our times outlined by quantum physics and its interpretations of the physical world as an indivisible dynamic whole or, using Paul Davies’s words, “an inseparable web of complicated energy patterns in which no one component has reality independent of the entirety; and included in the entirety is the observer.” [4] A juxtaposition of images showing neural and intergalactic connections may serve as an inspiring illustration of such a fundamental unity [5].

Pythagoras was the first person who took up the challenge of connecting the human internal world (*Musica Humana*: the music of a human body and soul) with the universe (*Musica Mundana*, later known as the *Music of Spheres*). His *Harmonia Mundi* was based on numbers and proportion.

The Pythagorean conviction that the essence of our universe is concealed in and governed by numerical relations not only influenced the geometrisation of western cognition, but today, the anthropic principle claims that fundamental physical constants such as Planck's constant, the speed of light, the gravitational constant etc. possess exactly such values as to make the biogenesis possible. According to its advocates, the phenomenon of life, and even conscious life, is an imminent feature of the universe, because it evolved from (mathematical) parameters which describe and warrant its existence. [6]

In turn, the Pythagorean vision of cosmic unity re-echoes in post-quantum theories promoting the view of the world as an undivided multidimensional oneness in a constant unfolding and unfolding movement or "holomovement", as David Bohm named it, throughout the whole of space. [7]

Referring to these studies, in my multimedia installation "The Hidden topology of being" I propose an imaginative journey into the heart of the matter. There, according to scientific suggestions, we find no molecules, no atoms; neither location nor time. On the subatomic level, only relations exist. {fig.4.}

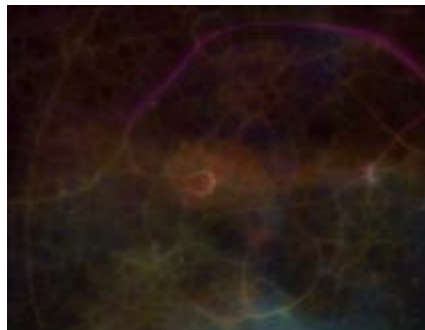


Fig.4. "Hidden Topology of Being" still from the 3D video-animation.
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What we perceive as "matter" turns out to be just energy condensed to slow dense vibrations of micro-strings. All their movements, rotations, joining and breakings, as Saul Paul Sirag put it, are "extremely complicated and rich in harmonics. If guitar strings can make wonderful music in 3D space, how awesome must be the 'string music' of 9D space!"[8]. In my piece I merge my imaginative visualisation of these subtle dynamics with fragments of

Rabindranath Tagore's poetry. Lines from "Ocean of Forms" and "Lost Time" [9] reveal one more, human, dimension that interweaves all folds and wrinkles of our world.

Secrets of spatial networks

Musical analogies not only revive Pythagorean's search for *arche*, but scientific research proved that abilities to differentiate sonic structures (primarily connected with survival strategies) played a big role in the development of the human brain and its capabilities to deal with complex systems in general. Nothing strange then, that there has been much effort to translate molecular structures into sonic ones.[10] In my current projects however, I am not so much interested in illustrating arrangements of monomers but in investigating the energy pathways between them.

If we assume that the essence of life is a piece of information, encoded in a sequence of letters, then this sequence has to assume a proper spatial form to become a message. The information transfer from 22 thousand human genes to 400 thousand highly differentiated human proteins (responsible for most biological processes ranging from shaping an eyeball to determining the way we move) is strongly correlated with energy issues and depends on interactions of the whole molecular network within a cell. This process is depicted in the central dogma of molecular biology and reveals the crucial role of RNA or rather the multitude of types of RNA molecules in it. Recent studies have been looking at this biomolecule through a new light based on our knowledge concerning both life processes and their origin. RNA can assume a form of a double helix like DNA or a folded thread like a protein; it can be both a replicator and an enzyme. It has become the best candidate for the "seed of life". Still, we can only speculate on the environmental conditions of molecular synthesis 3.7 billion years ago. The truth may lie in all of today's hypotheses. Maybe, under some circumstances, a few cosmic amino-acids met an enclave of proto RNA networks breeding in a clay strata which led to the catalysis and replication of molecular sequences. Such a scenario would bring together many cross-cultural myths concerning our beginnings. {fig.5.}



Fig.5. "Molecule", still from the 3D video-animation.
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This enigmatic molecule became the inspiration of my recent art projects like "Molecule" and "Intrinsic connections" which, developed in collaboration with the Genesilico Laboratory in Warsaw, are focused on the transformation of molecular spaces. "Intrinsic connections" is related to research into a new kind of hybrid RNA which has been given a working name of "werewolf". The scientific task is to merge two RNA molecules of no common evolutionary history (one naturally evolved and one synthesized). Scientific analyses suggest that different neutral (not coding) networks can interweave and intersect each other. The resultant molecule can switch between two different conformations and perform two different catalytic activities (become a "man" or a "wolf"). Novel folds and activities arise too, testifying that not only the exchange of genetic but also structural information can be a source of molecular hybridization and evolution. The practical outcome of the scientific research is to understand how to design transformative RNA molecules and to control the switch between ribosomal functions (wolf/man switch).

As an artist, I was inspired by the multifaceted identity of this molecule and its spatial metamorphosis. Searching for a conceptive tool which would help me to grasp and explore its complexity, I employed a notion of a labyrinth. It turned out to be a lucky and "trans-disciplinary" choice.

Indeed, to achieve its target form, a biomolecule has to overpass the labyrinth of all possible conformations. This labyrinth is not externally imposed on the molecule. It is its inherent feature and emanation. Subjected to energy flow and

thermodynamics, its landscape forms many energy traps, hills or valleys.

In “Intrinsic connections” the labyrinth has two determined areas: the state of “man” and the state of “wolf”. However they are neither dominant nor stable, just recognisable. The rest is a dynamic mist of possibilities referring to the immense amount of data remaining beyond the scope of current scientific interpretations. Each point is a different conformation, a fleeting identity, with its own unique position and “point of view”. Sometimes they quickly integrate creating some spatial patterns or run into the wolf/man zones and, in an instant, disperse again.

The notion of labyrinth has deep cultural connotations often related to identity issues: the gaining of maturity and wisdom. It is represented as a particular limitation and organisation of space which can be understood only when regarded as a complex whole. The labyrinth is more than a sum of its parts, just as a molecule is more than an assembly of atoms. It is both a state and a state of becoming.

In “intrinsic connection” the labyrinth is a model of a self-organising, non-linear system which, as all biological processes, is far from the thermodynamic equilibrium. There is an immensity of tasks involved today in understanding such systems and in acquiring a holistic view of their complex interactions that make life possible.

At present the mass of data produced by scientific experiments is huge. They are still waiting to be managed and incorporated into the labyrinth of knowledge. Ultra-modern computers, the latest developments in information technology, global databases and networks, make this challenge increasingly feasible.

Advances in our technological space helps us to transcend the natural limitations of our senses and to perceive what was previously “unseeable”. However they will not help us to go beyond what the human mind can imagine or interpret. To push these borders we have to use its creative potentiality which feeds on cross disciplinary and cross cultural inspirations. Cultural imageries provide us with a diversity of powerful means and ways of connecting a human being with his physical and mental environments. We have to revalue them in order to create meaningful tools

corresponding with contemporary challenges, desires and fears which would help us to understand and deal better with the complexities of the human space we construct.

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