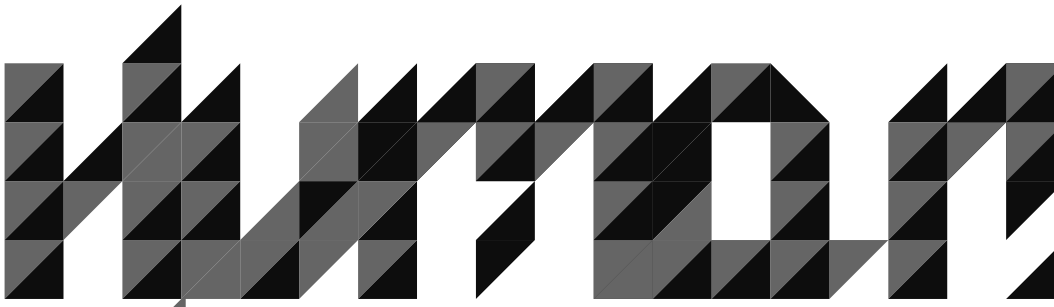
European Network of Heads of Schools of Architecture
European Association for Architectural Education

International Conference

Rethinking the Human in Technology Driven Architecture

This project has been carried out with the support of the European Community
and in the framework of the Socrates Programme.



RETHINKING THE HUMAN
IN TECHNOLOGY-DRIVEN ARCHITECTURE

EDITORS MARIA VOYATZAKI | CONSTANTIN SPIRIDONIDIS

european network enhsa of heads of schools of architecture

Education and Culture DG
Lifelong Learning Programme

EUROPEAN ASSOCIATION FOR ARCHITECTURAL EDUCATION

European Network of Heads of Schools of Architecture - European Association for Architectural Education

International Conference

Rethinking the Human in Technology Driven Architecture

Transactions on Architectural Education No 55

Editors
Maria Voyatzaki
Constantin Spiridonidis

Cover design: Emmanouil Zaroukas

Layout design: Dimitris Apostolidis

Printed by: Charis Ltd, Thessaloniki, Greece

ISBN 978-2-930301-53-2

Despite the attempt to transcribe with accuracy the debates from the workshop, the editors wish to apologise in advance for any inaccuracies of the interventions of individuals that could be attributed to the quality of recording.

List of contents

Initiations

Inspirations

Reflections

Contributions

(Re)searching a critically responsive architecture

(Re)thinking a critically responsive architecture

(Re)scripting and fabricating a critically responsive architecture

Teaching a critically responsive architecture

Initiations

Rethinking the Human in Technology-Driven Architecture

Over the past 10 years the research record of architectural education institutions in Europe have significantly shifted from research primarily based on the Humanities to research directed in and supported by Information Technology on experimentations in architectural desi
ch, has a direct impact on the entire construct of architectural
knowledge and design skills, as well as on the creation of the profile of the architect and the priorities for pedagogical strategies in architectural education. The more IT becomes ubiquitous by being integrated into almost everything people get their hands on, the more architecture tends to absorb this technological impulse, by becoming adaptive, responsive, transformable, intelligent and customized.

These new conceptions of architecture are accompanied with new terms like liquid, hybrid, virtual, trans, animated, seamless, interactive, emergent, parametric, algorithmic, machinic and self generating, thus producing a new architectural culture. That is a culture in which the terms and conceptions that have nourished architecture for centuries are replaced by their opposites: stability and solidity replaced by change, simplicity and clarity replaced by complexity and space replaced nowadays by (real) time. In the design domain, emerging techniques and methods seem to have absorbed the bulk of IT, mainly with regards to software applications, which influence greatly the way architects think, design and visualize their ideas. Meanwhile, the area of fabrication has been rapidly evolving so that the versatility provided by design software can now be materialized through advanced manufacturing equipment, previously employed only by the industry. Moreover, advancements in material science have also been supporting experimentation in that direction. Last but not least, this new culture has progressively established its ethos in the education of the architect detectable in student design works, in the new nature of the design studio (lab) as well as the gradual devaluation or even elimination of modules related to the Humanities in the architectural curricula and their being replaced instead by modules on scripting, biology, representation and simulation software.

The paradigm of nature, the development of more powerful, sensitive, interactive and intuitive software as well as the ability to experiment with electronic assemblies have facilitated an ever-growing tendency for responsive architecture. One of the most significant shifts of contemporary architectural thinking in our fast changing world is a strong inclination towards an innovative experimentation adaptable to the speed and pace of changes occurring in our mind, soul and body. As a result the whole practice is nowadays moving towards responsiveness. Thus, design tools are used according to user demands and needs, which are now conceived as unstable and transformable while fabrication methods develop to respond to design idiosyncrasies, and space is designed to respond directly to changing human behavior and environmental conditions.

However, voices criticizing this digitalization of architectural thinking are becoming more boisterous. Not only are they the voices of practitioners and educators, who steer clear from avant-garde ideas and experimentations but, more significantly, of those who have been strongly involved and engaged in the development, implementation

and theorization of the contemporary technology-driven architecture from its infancy. The common grounds of these critics focus on three main orientations; the design process, the nature of the outcome, and the role of the architect. The digitalization of the design process and its development as an imitation of the biological, morphogenetic process is questioned on its potential to continue to be considered as an act of creation when it follows a purely mechanistic development, sterilized by the decisive presence and the creative role of cultural values. The architectural outcome of such a process is questioned on its merit to adequately represent our contemporary culture when the dominant characteristic through which it gains its value is its capacity to be passively adaptive and responsive to preprogrammed external human or environmental stimuli. Finally, what is questioned is whether the architect more as a script editor-programmer than a thinker-maker working on values to give form to our everyday life, can safely translate, in parametric terms and the script language, the complexity of human senses and behaviors. The common denominator of all this questioning is a broader concern that, by overemphasizing the technological capacity of the available means, we risk considering the means as objectives and thus lose the human being as the ultimate end of architectural creation. Is IT the end or a means to an end?

All the above issues are translated into new questions that have nourished research and experimentation, trigger off debate, contemplation and influence the practice and education of the architect. Is it possible to find the human being in IT driven architecture? Is it possible to have an adaptive architecture in which the presence of the human being will be more influential and decisive? Can the contemporary technological means assure a value-based responsive architecture? Can we have an architectural production, which will not only reflect some of the abilities, constructions and properties of the alive, but also made to be receptive to the senses, the feelings, emotions and sensations of the human being which will inhabit it? Can we use advanced information technology to protect architecture from becoming a consumable, self-complacent object, fascinating for its elementary intelligence, admired for its advanced technical competences, attractive for its formal peculiarity but distant from those who are invited to appropriate it by investing in its spaces and forms feelings, aspirations, cultural attitudes, and values emerging from social life?

This volume contains essays the authors of which have been invited to give answers to the above questions in the framework of the International Conference entitled "Rethinking the Human in Technology-Driven Architecture" organised in Chania, Greece by the European Network of Heads of Schools of Architecture under the financial support of the Lifelong Learning, Erasmus, Academic Networks Program, the European Association for Architectural Education and hosted by the School of Architecture of Technical University of Crete. The authors of the contributions are architects, teachers and researchers in architecture and their texts have been produced after their presentation in the Conference incorporating this way the comments, remarks and outcomes of the debates that took place in the context of this event.

The reader of this volume can find a record of the research undertaken in different parts of Europe on architectural design and the output produced by schools of architecture aiming at advancing responsive and adaptive architecture critically towards a more sensitive involvement of the human values. It also presents cases of architectural design and fabrication where information technology is amalgamated with a values-

what makes [and how to make] their vivarium a "better place" for its dwellers! Initially launched in the eighties to gain insights into the design of human-machine interfaces, the project differs from others of its kind (olpc, LOGO, Microworlds) in that the children were working in a real "augmented garden". Most important, Kay didn't just use the gardening metaphor as an entry point to using computers, but the computer, and many other tools, as a means to keep the garden alive And to Alan a primary school seemed an excellent choice because younger children are still "in their bodies", steeped in the here and now, and open to their senses. Their thinking is not yet bound by adult certainties and conventions.

It is also Alan, working with children, who reminded us of the obvious, regarding digital technologies: "we adults call technology any tool that was invented – after I am born :) Not so for kids! One could write an entire new essay, just on that!

Acknowledgements

Many thanks to Maria Voyatzaki, Constantin Spiridonidis, Marianthi Liapi and Kostis Oungrinis, and the participants in the 2011 "sense[res]ponsive environments for children" workshop, in Chania, Greece. I extend my thank to Yasmine Abbas, Cearan Benson, and Sherry Turkle, as well as to my colleagues from the LEGO Learning Institutes, Exploratorium Science Museum, and AIANY, whose works are an inspiration to my thinking about people and places.

Notes

1 We call the changes "epistemic" because they question how pre-digital cultures have come to define knowledge and to *think about thinking* itself, and how their views on how to promote everyone's potentials are projected on those who don't think like them!

2 Cearan Benson defines place as a "humanized personalized space", and he uses the term *place-time* to indicate that "in personal and collective memory certain places are inexorably constituted by their […] connections with, and embodiement of, certain moments in experiential time […] Place situates time by giving it a local habitation. Time arises from places and passes between them (Benson, 1993. p. 6).

3 Scaffolding is about supporting learners to achieve beyond existing capabilities by giving them a 'step up' through questions, pointers, or encouragement, rather than direct instruction. Ultimately, the learner should reach a point where they wont need the scaffolding support. In this case, the mere knowledge, or perception, that there are trusted others on whom one can rely on, becomes enough to support self-reliance.

4 There is much talk about 21st century skills and standards these days, and much research is being fueled into redefining what today's youngsters ought to know, or learn, in order to become active and successful players in tomorrow's world (Jenkins, 2009; Weigel, James & Gardner, 2009). While important, such guidelines often emerge from adult projections and as a result, they tend to downplay what the youngsters themselves are contributing. As mentioned earlier, our focus as a psychologist is on the emergent traits, as exhibited by the natives, more than on adult projections.

5 The craftsman establishes an intimate connection between head, eyes, hands, and tools. And as he perfects his art, the materials at hand *speak back* to him through their resistances, ambiguities, and by the ways they change as circumstances change. An enlightened craftsman is one who falls in love with the materials and becomes so fluent in using his tools that he feels at one with them. According to Sennett, such appreciation and fluency are in no way contrary

Antonino Saggio

Sapienza University of Rome
Italy

GreenBodies
Give me an Ampoule and I will Live

This essay summarizes my research of the last five years and is projected to become the next chapter of my last EAAE-ENHSA keynote speech delivered five years ago.[1]

When I delivered that speech according to my usual practice, I created a hidden link, which expanded the lecture so that the audience could see the images, read the texts, access further pages and,when the conference was over – listen to the audio, all from this one link.[2] This use of the Internet is relevant because content and container are interwoven. If I want to speak about processes, interconnections, ecological systematic thinking and IT how can I do it with a linear (and private) slide presentation? We are on the web; let's share, and particularly use the inner philosophy of electronics: Interconnections.[3]

The 2005 keynote was entitled "Give me a cord and I will build.... Construction, Ethics, Geometry and Information Technology".[4] This one is entitled "Green Bodies. Give Me an Ampoule...and I Will Live. Rethinking the human: Ecosystems for today's architectures." It is evident that key words have shifted from: "construction," "ethics" and "information technology" to "ecosystems" and "green bodies." The two main key words have also changed.

"Cord," which was used then as a symbol of geometry and construction and at the same time as the instrument to build; has transmuted into:

"Ampoule" as the symbol of life and at the same time as the instrument with which to create ecosystems.

The title "Give Me an Ampoule...and I Will Live" should begin to create the mental framework in which we are moving in this essay. I apologize for the length and complexity of some passages. It is more challenging to go along new lines of research than to present well established ones.

This essay is organized in seven parts. Each part is a "city" which we can inhabit for all our scientific life or just look at briefly from an airplane. Nevertheless, all seven cities are part of a common territory. It is a system of relationships to facilitate the birth of design ideas, which are relevant to our topic. Here are the seven parts of the talk:

1. Hybridization between Systems of Architecture and Systems of Nature.
2. Parallel Lines Do Meet. The Awareness of Limited Resources.
3. Processes, not Objects.
4. Synergy. Vernadsky + Buckminster Fuller = John Allen's Scientific Experiment.
5. Biosphere 2 and Closed systems.
6. Current researches.
7. Principles of Green Bodies.

Hybridization between Systems of Architecture and Systems of Nature

> *The idea of today is that architecture must become a reactive landscape, complex, animated and alive in a process of combination with other elements of technology and of the environment.*
>
> *The aspect of hybridizing the natural and the artificial is thus moving towards the center of the conception of architecture nowadays.*

The nature intended in this concept is no longer floral or "art nouveau-style;" neither is it the nature of the masters of Organic Architecture, counterpoint to the mechanical and industrial world. Current concepts of nature have in fact become much more complex, much more difficult, much more "hidden." This nature is also investigated by architects and designers with an anti-romantic eye through the formalisms of contemporary science (fractals, DNA, atoms, the leaps of an expanding universe, the relationship between life and matter, topological geometry, animated forms), in other words, through the categories of complexity. Hidden in this context are the figures of flows, the wave, whirlpools, crevasses and liquid crystals; fluidity becomes the keyword. It describes the constant mutation of information and places architecture face-to-face with the most advanced research frontiers, from biology to engineering, to the new fertile areas of superimposition such as morphogenesis, bioengineering or biotechnology.

IT endows architecture with reactive systems capable of simulating types of behavior in nature, in reacting to climate, usage flows and ultimately also emotional behavior, and so offers a new phase of esthetic research.

The approach described above, opens the path to different research. In order to better understand the idea of hybridization between architecture and nature, I went back to a moment in which there did not exist separations between man and land, construction and nature, rational and magical. It was a moment in which the interconnections among things were more important than the things *per se*.

The Etruscans had an integral, magical, heuristic relation with nature. Vie Cave are the most relevant examples of this attitude. They are long, human-excavated processional streets down which the dead were brought to sepulture. At the same time, the Vie Caves were used to celebrate nature. For the Etruscans, nature speaks. She lives and breathes in a sphere shared with all the other creatures. Nature is alive.

Humans, animals and land were interrelated, interconnected; they were part of the same "system." The governing forces of this system could not be explained by "analytical" reductionist means but only by "ecological" ones (i.e. based on interconnections, therefore antiscientific from a positivist, reductionist, analytical point of view). This is the central concept derived from this research path. Hybridization is not only a "formal" device; it is rooted in profound ecological thinking. It is an action that is part of an "ecosystem."

From a more direct and "architectural" point of view, Etruscan is the civilization of the "section," because it is the section that celebrates the marriage between the earth and human artifacts.

The "plan" is the symbol (and the instrument) of the Roman military and expansionist attitude. If the plan is the symbol (and the instrument!) of rational domination, the section is the symbol/instrument of ecological inhabitation. If Etruscans hybridized architecture and nature through section, the Romans "posed" independent objects on the land: Aqueducts, streets, and bridges.

Later on, towards the beginning of the nineteenth century all the world of mechanical artificiality related to the Industrial Revolution developed that "rational" idea of domination and infinitive conquest much further.

> ***If an "ecosystems" approach to architecture should take place, then architecture must belong simultaneously to the land and to the cloud (i.e., Information Technology). This interconnection is the crisis and the challenge in front of us.***

The proposal for a Museum for Francesco Borromini in Rome[5] is a good example of how these ideas of Land, Architecture and IT may take shape today. This final thesis starts from the notion that "Modernity is what turns crisis into a value and gives rise to an aesthetics of rupture."[6] The crisis that precipitated this project was the fracture provoked by a thruway in the old historical park of Villa Pamphilj. From historical research, the presence of Francesco Borromini emerged in the planning and design of the villa. The Doria Pamphiljs were indeed his clients for the Piazza Navona Palace in downtown Rome. From the Borromini presence emerged the brief: A mixed use project that, as a driving force, proposes a Museum dedicated to Roman Baroque architecture - MOB. The project's development was based on the use of a diagram inspired by one of Borromini's ceilings. It was an inspired choice. As the ceiling lines "connect" the different walls of Cappella dei Magi, in Rome, the same family of lines may connect the opposite sites of the park. Borromini's drawing was pulled and stretched to adapt to the site that had been cut by the thruway. The project idea developed as a membrane structure, half natural and half artificial that was modeled along the diagram's lines. The architecture is indeed a hybrid: Building, land, bridge and nature at the same time.

This architecture belongs, at the same time, to the Clouds of Information Technology.

> *In this process of hybridization the catalyst role is, of course, that of Information Technology that is the key for an entire group of connected reasons.*
>
> *In the first place, the information era provides an overall different model of the city and urban landscape, as well as in part the surrounding territory that has mixed uses with overlapping flows, open 24 hours a day for production, leisure, social, and residential activities, where natural and artificial elements are woven together with the combination of functions and uses.*
>
> *In the second place, information technology supplies the "mathematical models" to investigate the chemical, physical, biological, and geological complexity of nature. These simulation models permit structuring new relationships in projects that consider reasoning and dynamics. In this process, information technology supplies the essential tools for first creating, then designing, and finally constructing designs conceived with these complex systemic approaches.*
>
> *In the third place, information technology endows architecture with reactive systems capable of simulating natural behavior in their reaction to weather, flows and usage, as well as to ultimately emotional behavior, and*

thus offers a new phase of investigation into a concept of landscape that is not just "simulated" in architecture but actually and physically represents several aspects. This means defining an environment and an architecture that not only evoke the formative rules of landscape and nature, but also propose environments capable of interacting and evolving. In this context, information technology enters directly into the fiber itself of new buildings, first by digitally designing them, and later building them using new construction techniques, but above all by exploiting dynamic electronic interconnections to create environments that react to variations in real situations and flows to form a sort of IT landscape in new buildings.[7]

Not only is IT indispensable in the process of ideation and of taking shape of many projects today; in many cases the architecture incorporates contemporary electronic technologies to actively partner in the environment. In the case of MOB, the edifice transforms and purifies the air, heavily polluted by the passage of cars underneath it. The building becomes active and can be seen as an alive being.

Among the research work produced by NitroSaggio is the built prototype of "A New Primitive Hut." This is a good example of an architecture that creates a hybrid half natural and half electronic environment. The movement of the person in this new "hut" molds the environment by changing interactively the sound. In this way, "the occupant shapes information while he/she moves demonstrating that the current idea of space 'is' also informational." [8]

Parallel Lines do Meet
The Concept of Limited Resources

The idea of the city for the Functionalist CIAM (the International Congress of Modern Architecture) evoked a city in constant centrifugal movement as if it were a flywheel that could "youthfully" and mechanically expand, absorbing pieces of the surrounding territory. We know this model has entered a crisis period over the past few decades for a whole range of reasons, not the least the awareness of the limited nature of resources and the birth of an ecological consciousness. As we have mentioned, the presence of the information era has contributed greatly to this because the change in the production model (robotization, miniaturization, the decentralization of heavy, polluting industries) creates new opportunities and frees up resources. In particular, the great industrial areas becoming available create the possibility of an epochal reclamation project. Reclamation is an essential key word here since green spaces, nature, and park facilities can now be introduced into areas frequently filled with high-density construction. At the same time, large natural areas must be conserved and respected and not eroded infinitely by the undifferentiated expansion of new suburbs even if they are supplied with wireless broadband.

More specifically, if CIAM's idea of nature was "green," i.e., something that resembled a patchwork on a plane where green zones contrasted with residential, industrial, or office areas, the modern concept is one of land-

scape (cf. Landscape); in other words, a much more complex idea that sees nature and constructed areas "together," a constant hybridization between the formative rules of the urban landscape and the architecture itself of buildings. To sum up, architecture and urban planning themselves make up today's landscape. Architecture takes what it does not have, absorbs it, transforms it, makes it its own, and reconstructs a new idea of nature.[9]

We do not believe in the presence of unlimited resources and therefore architecture and the city cannot indefinitely expand. The vision of the never-ending railways at the conquest of the Far West or of the Urban highway extended towards the horizon shaped a long phase of architecture and urbanism. It was an idea still embodied in the Deconstructivist movement of the eighties and the nineties. You may recall from *Between Zero to Infinity* by Daniel Libeskind, for example.

To think about ecosystems for today's architecture I propose another formula, another vision: instead of "From Zero to Infinity" I propose: "Parallel lines do meet".

We have to change our point of view once again. "Parallel lines do meet," means that we live in a closed system with limited resources. We do not live in the never-ending flat plateau of Euclidian math, but in the curvilinear, negotiable topological world of planet earth! We "are" in this closed system, we are in this planet, and in planet earth parallel lines meet.

Not only are we in a world of limited resources, we are also in a world in which our actions can kill or mend the world. If we continue to perforate the earth, for example, it is rather clear that we are going to kill it at the end. It is Earth's crust not only as a metaphor: Just think of the "cycle" of petroleum. But at the same time we can think of actions that can mend, ameliorate, and be compatible. And Architecture must be with science at the forefront of this search.

Systems: Processes not Objects

The idea of the functionalist city was implicitly tied to the idea of the assembly line that organized a series of operations to be performed sequentially so as to achieve efficiency in the production cycle. Each phase was constantly perfected and optimized to then move onto a subsequent phase.

But the concept of "before and after," "cause and effect," "if … then," related to mechanized, serial production has now been replaced by a concept of simultaneous processes, subdivision of cycles, the presence of alternatives, in other words of "what...if."

The network that diffuses, interrelates, interconnects, and makes the development of processes both global and local has inevitably replaced the figure of the line.

The aim of the production system is no longer the uniformity and homogeneity of the final result (guaranteed by constantly greater improvement in the various production phases) but exactly the opposite. It is the

personalization of the product based on individually activating several different connections each time in the informational network.[10]

We want to focus on issues related to education and curricula. Up to the recent past, architecture was expected to produce primarily artifacts, i.e., objects. To produce objects in the industrial era, the assembly line was the way to go and the flowchart, the model from industrial production, moved to education. Accordingly, teaching was chopped in areas and subareas following the same principle used for the industrial production. But if "We have to change at lot," as professors Spiridonidis and Voyatzaki stated, and if we want the address the issue of Ecosystems, we have to modify that.

We have to start addressing teaching through the development of "processes" and not "objects." Electronic and ecological thinking are both based on interconnections. Architecture should not produce one "object" but a series of methods to implement relationships and families of solutions.

Therefore, scripting and parametric design, so popular in these days, are not only a fashion, they are rooted in this shift from object to process! It is a Copernican revolution. This brings us to two other rather important factors of change.

The first one is that contemporary teaching must be more oriented towards the development of "Projects." In a world dominated by information, and with extremely easy access to knowledge, what becomes critical are the motivation, the methodology and the instruments to study. If we create projects that motivate students by their inner strength and necessity, if we teach how to structure the search of information, if we provide the basic guidelines to the direction in which to look and in the complexity behind it, students will educate themselves. Recently this pedagogy of "teaching by projects" has been proven highly successful.[11]

The other interesting factor of modification is what we call, in our teaching jargon, "maratonda." This reverses the old "in-out" linear flow and substitutes a circular, cyclical "in-out-in" process which is attentive to the use and re-use of resources.

Here is one example. This project is called "Place Less. From Playground to Urbanground: Monitoring and recycling"[12] and the crisis was the condition of homelessness in Rome, the pollution and the way to have more intelligent and creative tourism for the young. Well, you may think that we are crazy. How can all these three elements be put together?

The solution was rather interesting. The students designed a little mobile device (car, chart and bicycle at the same time) that had different positions. The user can cycle, collect, trash, recycle, and check the pollution or just tour. The mobile device can be offered to homeless or poor people to earn some extra money, or can be rented. The device has also a place to rest in a sort of urban park that is organized as movable landscape.

We do not ask, "design a vehicle for the homeless." We frame knowledge and challenges; we provide methods and instruments. The students find "a crisis." We work with them to shape the concept, articu-

late the brief, and develop the project. Pedagogically, students "do not learn by doing" in Deweyan terms, but rather "learn by necessity and by desire".

In this process students face a number of issues, study different matters, and develop specific skills. This example refers to a class based on the relationship between IT and Architecture. When a more direct architectural design is required, other approaches are developed, but we cannot address them here for lack of time.[13]

Synergy
Vernadsky + Buckminster Fuller = John Allen's Scientific Experiment

Now let's go to the more typical cultural-informative part of the conference. I want briefly to talk about a fundamental project for the creation of Ecosystems for Today's Architectures.

In 2006 I met John Allen, the inventor of the scientific project Biosphere 2. I consider myself lucky because I entered the ecological world with one of the top ecologists. Through Allen I understood things that I could not get "just" studying the literature. What follows are some of these findings.

Let me underline one of the most important principles of ecological and systematic thinking: synergy. I understand synergy as "biological mathematics." While in algebraic mathematics 1+1 = 2, in Synergy 1+1 can make 3 or 4 or 5 or -1 - 2. If the minimum principle of synergy applies than 1+1 equals 3.

Now, 1 + 1 = 3 is a good formula of "creativity." Creativity is a term that applies to creative thinking as well as to the most creative action of all: The "creation" of life.

Is it not true that in sexual reproduction 1+1 makes 3? Starting to think in these terms opens new doors indeed. For example, architecture is one of the greatest synergies one can think of. We take rough materials and by putting them together we increase the value of the product. We cannot calculate the "cost" without algebra, but we cannot understand "the value" without a feeling of the synergetic process we went through to create it. We create energy, to a level that is impossible to create with a normal sum.

John Allen created an incredible synergy between two men. The two men were, on one side, Buckminster Fuller, and on the other Vladimir Vernadsky.

Allen, by 1971, was already calling his ranch in Santa Fe, New Mexico, Synergia Ranch. It was his vision of life and also a homage to the chapter "Synergy" dedicated to the subject by R. Buckminster Fuller in his coeval volume *Operating Manual for Spaceship Earth*. Nowadays, interest in Buckminster Fuller has been revived but for my generation he was almost completely cut out, as if he did not exist. He was considered a strange, humanistic engineering fellow who wanted to put humans and technology together!

Allen and Buckminster Fuller had a strong relationship in the last phase of the latter's life and many ideas took form. His book Operating Manual ... is a fundamental book, some kind of "manifesto" of ecological thinking. It is a small book, important to

read, where several ideas are interconnect. Crucial is the idea of finite resources and of closed system: The Spaceship earth of the title of the book.

Second, is the need for being interdisciplinary, a concept that Bucky takes from the culture of sea people. Sea people must know everything, from stars to winds, to underwater rocks, to geography and animals, to culture habits, religions and languages. Buckminster Fuller dedicates fantastic pages to pirates. Let us not forget, on the other side, that the technology for "the rest of us," that which we are using today, was created by a small group of people at Apple Cupertino under a pirate flag.

So the idea of "energy" created by an interdisciplinary group of people "closed" in Renaissance Florence or in Apple's "Texaco Towers" applies quite well to Bucky's thinking.

Allen underlined some aspects of Buckminster Fuller's method, through an algorithm that shows a method to have a synergetic approach. Here is the citation:

> *If you take the synergetic overall approach then proceed to a comprehensive anticipatory design;*
>
> *if you've started on this, then make detailed macro-comprehensive and micro-incisive studies;*
>
> *if these are completed, then proceed to do more with less; ephemeralize;*
>
> *if you've ephemeralized, then computerize to check rationality and to communicate;*
>
> *if you've computerized then check if you've increased the wealth of all involved.*
>
> *(...)This algorithm constitutes his greatest contribution to dealing with the challenges coming toward humanity in the next century, a time of great planetary troubles, which he metaphorically referred to as humanity's final examination.*[14]
>
> ***Do not forget therefore these five steps: 1. Comprehensive design ("have the whole"), 2. Macro and mini tests, 3. Do more with less, 4. Computerize and 5. Assure the increased value!***
>
> ***If there is an indispensable point of reference for Ecosystems for Today's Architectures, it is represented by Buckminster Fuller.***

And here comes the second man whose contribution allowed Allen's synergetic invention:

> *Vladimir Vernadsky (Russian: 1863 – 1945) was a Ukrainian Soviet mineralogist and geochemist who is considered one of the founders of geochemistry, biogeochemistry, and of radiogeology. His ideas of Noosphere were an important contribution to Russian cosmism. He also founded the National Academy of Science of Ukraine. He is most noted for his 1926 book The Biosphere in which he inadvertently worked to popularize Eduard Suess' 1885 term biosphere, by hypothesizing that life is the geological force that shapes the earth. In 1943 he was awarded the Stalin Prize.*[15]

We will talk about Biosphere later, for now let's notice that Russians - via Vernadsky - use the word "cosmos" while Americans use the word "space." The difference is important because the idea of Cosmos underlines that forces "are together," they are interconnected and interrelated. Technically, Vernadsky was the first to prove that "oxygen, nitrogen and carbon dioxide in the Earth's atmosphere result from biological processes." [16] This finding gives shape to the development of the concept that the World can be seen as a series of interlocking spheres. They belong, for Vernadsky, to the sphere of life (which is of course called "Biosphere"), to the sphere of Geochemistry, to those spheres of cultural knowledge and technology.

> ***If cosmos is "solid," space is "empty". If cosmos is regulated by complex and probabilistic interrelationships, the absolute Newtonian laws of physics can govern space, if space implies the possibility of an unlimited expansion; Cosmos implies the necessity of the coexistence of different forces.***

Now, not only animal behavior influences the inanimate sphere but cultural and technological ones influence the biosphere. This is the crucial aspect of this approach. As Allen clearly underlined to me, in an ecological approach there is no such thing as the environment on the one hand, and man on the other. The concept of environment is anti-ecological by definition, whilst ecology is about the interconnections!

John Allen, a geologist like Vernadsky, and at the same a personality profoundly connected to literature, put together the operative, profound, revolutionary, nonconformist, holistic thought of Bucky and his own geodetic technique with a philosophy stemming from farfetched and, in fact, politically opposed culture in the era of the USA-USSR Cold War. Vernadsky achieved cosmic reasoning and saw geological, biological, atmospheric and human phenomena as an interacting whole of forces and forms.

After the construction and invention of the Synergia ranch, Allen built a ship, following Bucky's understanding of the interdisciplinary practices of sea people. Called the Heraclitus, the vessel has since 1974 been circumnavigating the world collecting data from all its different spheres. But the great achievement of Allen and his Ecotechnics group was the ideation in the eighties (after a series of interdisciplinary conferences, and the construction of other preliminary projects) of Biosphere 2: a great, probably the greatest and most interesting ecological experiment ever built.

> *Biosphere 2 is a 3.14-acre (12,700 m2) structure originally built to be an artificial, materially-closed ecological system in Oracle, Arizona (USA) by Space Biosphere Ventures, a joint venture whose principal officers were John P. Allen, inventor and Executive Director, and Margret Augustine, CEO. Constructed between 1987 and 1991, it was used to explore the complex web of interactions within life systems in a structure that included five areas based on natural biomes and an agricultural area and human living/ working space to study the interactions between humans, farming and technology with the rest of nature. [2] It also explored the possible use of closed biospheres in space colonization, and allowed the study and manipulation of a biosphere without harming Earth.*[17]

Biosphere 2 has little to share with the greenhouses that have been built around the world - the most famous one being the Eden Projectin Cornwall, Great Britain by Nicholas Grimshaw. These projects can be considered very interesting from an architectural point of view, but they are not "ecosystems," they are not "scientific experiments:" Biosphere 2 is different! It was built as an experiment and it did work. Not only were dozens of patents on different issues created, but also Biosphere 2 was fully tested. Eight people lived in this completely closed system not for one but two years!

Biosphere II and the Closed System

At the core of this project there was the ingenious intuition that the idea of the biosphere as promulgated by Vernadsky could be combined with the ecological observation and technical inventions of Fuller.

Biosphere 2 was thus built in 1991 at Oracle in the desert near Tucson, Arizona, and still affirms itself as an extraordinary work of both engineering and ecological science. Allen, assisted by a team of numerous consultants, of whom the architect Margaret Augustine and the engineer William Dempster should especially be remembered, so realized a project according to the image and likeness of the terrestrial biosphere that an interacting whole of geological, ecological and human forces formed of seven biomes (ecologically balanced systems) could serve to study systematic phenomena.

Biosphere 2 was based on these dynamically balanced systems where carefully studied percentages of plants, microbes, water, animals and air were in a cycle of continuous regeneration. Through complex research with many experts specializing in different areas, the seven biomes were thus determined (from the Amazon forest to the Great Coral Reef, from the anthropological Mediterranean environment to the same ocean's marine environment) all housed within great glass paneled surfaces that covered an area of more than a hectare. Living and relaxation areas and laboratories were also integrated into the structure.

The experiment allowed, among other things, the patenting of various systems and technologies that brought up to 100% the recycling of water, human and animal waste as well as the autonomous generation of food and a minimum loss of air inside the great closed environment.

Eight scientists, including Mark Nelson and Ray Walford, lived sealed up in this environment for two years, experimenting with its efficiency.

After this period, Biosphere 2 was conceded to Columbia University and then to the University of Arizona that modified its structure. Nonetheless, this extraordinary event marked the basis of a possible systematic development of architecture, an architecture that need not necessarily be connected to infrastructural networks but is autonomous with regard to its own vital and energetic cycle.[18]

This is a picture of scientist, Dr. Clair Folsome[19] who in the mid-sixties did the first experiment to prove the perpetuation and development of life in a closed system. It is the key image of this talk. Folsome's work proves that water, air and microorganisms can be in equilibrium for a long time if they are sealed in a close environment. An ampoule is an image closer to our earth and its atmosphere than is a never-ending railway track! Give me an Ampoule… and I will live.

From this link[20] it is possible to access a site created by the Italian photographer Toni Garbasso, and to watch and navigate in a spectacular 3D immersion Biosphere 2

which is currently managed by the University of Arizona. Unfortunately, today many of the scientific aspects of Biosphere 2 have been dismissed. The cruel destruction of the scientific data and material of the project, even the removal of the original soil, of all plants and seeds, was an act that in some moment in the future will be the subject of a movie.

Biosphere 2 was built with donors' contributions and money from a private developer who was seeking the possibility to use the technology in a field of increasing interest including that of NASA. But, after a couple of years after its completion a terrible attack was undertaken against it. The establishment cannot accept the idea of the ecological "system" as shown in Biosphere 2 because it was a real challenge for the way to operate in the current economic "system." One system was against another. Just imagine what it means to prove, in a real experiment of that magnitude, how to avoid the use of pesticide or of any other chemical products for agriculture. Try to imagine what this means for the huge market of chemicals in agriculture. Energy is another issue, recycling of water, use of waste etc. At that moment the Internet did not yet exist and the media were controlled from the top with very little possibility to react. A converging attack of the media, governmental ecologist and politics succeeded in moving the original creators out of the projects and, exactly as happened with the Apple Macintosh when Jobs was fired, destroying the basis of the project. I recently published a book on the history of the last century - *Architecture and Modernity. From Bauhaus to IT Revolution*, Carocci 2010 -and in this book I proudly included Takis Zenetos, Samuel Mockbee, Paolo Soleri and the history of Biosphere 2 and John Allen.

If Bucky can be an indispensable reference I think that Biosphere 2 is a fundamental example to study in order to address Ecosystems for Today Architectures.

Some Examples and Current Research

New designers seek to give form to an idea of architecture born out of systems of dynamic interconnections, interrelations, mutations, and topological or parametrical geometries, typical of the world of information technology. A whole series of architects are giving shape to a sort of hybrid environment between nature and technology. Although this may not have the clarity of that "collectively shared" representation assumed by the early works of Hadid, Gehry or Eisenman, its features have already been outlined.

This notion of a computerized landscape is closely linked with contemporary scientific methods of investigation and simulation. Structured through information technology, this idea uses the term "complexity" as a sort of key word. At various times it can show typhoons, cloud formations, the reproductive mechanisms of DNA, or sedimentation of crevasses or terrestrial masses. But the difference between this generation and the previous is that these experiments are not performed with sketches or metaphorical images, but are investigated directly through computer simulations. The genetic mechanisms of various phenomena are studied and formalized (i.e., interpreted with mathematical equations) in these simulations.

The mathematical formalization guaranteed by information technology leads to the birth of real project strategies (particle systems, attractors, modifiers, etc.) that guide and conceptualize the logic for developing the project. In this case, computer technology is not a tool for realizing a complex landscape considered independently from electronic media, but rather it studies phenomena taken from the world and matter, and by formalizing these phenomena identifies variations that slowly but inexorably lead to new concepts of architecture, in an inextricable weave between the object of study, computer modeling, and architecture.

We can pinpoint, very briefly, some of the current architectural research in this area. One case of interest is surely Francois Roche and R&Sie(n). Roche is working towards an idea of architecture as a hybrid body. Recently we discussed Biosphere 2 and he was not very interested. Roche may sometimes be too focused on the formalization in architecture of outside aspects of nature rather than on the inner functioning of ecosystems. Many are waiting for a small but convincing built project from him, but I think his work is crucial and must be studied seriously. A younger emerging group is Ecologic Studio formed by two Italians, Poletto and Pasquaro who moved to London. They came out of the Emergent Technologies Masters Unit at the AA headed by Michael Hensel, who has been on the forefront of the idea of combining engineering with Information Technology and ecological thinking. One of the best examples of an innovative approach is the work of the Polish scholar-scientist and artist Zbigniew Oksiuta, who collaborates with Max Planck Lab in Cologne, Germany. Oksiuta is developing prototypes of habitable spaces that grow from artificial material in water. These new structures are not only habitable, but can be used in different contexts and circumstances and, in some cases, they can also be edible. I was very impressed by Unit 23 led by Bob Sheil and Emmanuel Vercruysse at the Barlett School, UCL - for their capability to create prototypes of cyclical ecological behaviors within high design and graphic standards. I have dealt, in depth, with several of these groups in the last book I edited . In this book there are essays of members of the Nitro group that go into great detail to describe the above mentioned current research.

So, Green Bodies, at the end. In order to give life to "something" we, as highly symbolic beings, must give it a name. Giving a name means recognizing that from infinite and often-accidental creations only that one is what we really desire and is the one we were looking for. Giving a name is an inscription in the sphere of desires!

So we have named the long trail of this lecture "Green Bodies.". Green Bodies share at least six fundamental characteristics:

1. ***Green Bodies are not "add on" or "plug-in" technological support for environmentally sound buildings but, on the contrary, represent a different and complete rethinking of the very same idea of building. Green Bodies are living and dying organisms.***
2. ***Green Bodies are generated through a process of Convergence. This means that we are aware of the role in the Biosphere, of all interconnected spheres including the cultural, technological, historical ones.***

3. Green Bodies are strategically designed based on Buckminster Fuller 5 Rules' algorithm.

4. Green Bodies are capable of intelligent, interactive, even emotional behaviors. These behaviors become an active part of the world.

5. To describe, design or - even better - generate Green Bodies creators must use appropriate verbs: Not only the old verbs (to fold, to bend, to graft) that metaphorically relate to the form of land as in the land architecture phase, but also really organic verbs. Green Bodies do sleep, smile, breathe, and sweat. Bucky wrote "I Seem to Be a Verb" in 1970.

6. Each generation of Green Bodies generates - in a progress of natural evolution - new specimens.

You can interpret these six points in many ways. They could implement an "operating manual," a soft manifesto, a checklist, a chart to add modify or expand, the index of our next book, or the topics for 2017 talk.

Notes

1 The conference was entitled "(Re) searching and Redefining the Content and Methods of Teaching Construction in the new Digital Era" EAAE-ENHSA at ESTAV in Valles, Barcelona, 22 September 2005.

2 http://www.arc1.uniroma1.it/saggio/Conferenze/Creta/

3 Among many other books in the "The IT Revolution in Architecture" series it appeared *The Architecture of Intelligence* (Birkhauser, Basel, 2001) by one the best continuators of Marshall McLuhan, Derrick de Kerckhove. See http://www.arc1.uniroma1.it/saggio/it/

4 EAAE-ENHSA ETSAV Barcelona 22 September 2005 published in AAVV Maria Voyatzaki (ed), *(Re)searching and Redefining the Content and Methods of Construction teaching in the new digital era,* EAAE-ENHSA, Athens 2005, pp. 13-34 see http://www.arc1.uniroma1.it/saggio/conferenze/Barc/Eaae05.htm

5 Matteo Alfonsi Thesis, Antonino Saggio Advisor, Univ. La Sapienza, Facoltà di Architettura L. Quaroni Roma 2006 "MOB il museo dell'opera Borrominiana, una macchina atmosferica per trattare la crisi di villa Pamphilj". See http://www.arc1.uniroma1.it/saggio/didattica/Tesidilaurea/Alfonsi/

6 See Antonino Saggio, *La rivoluzione informatica in architettura*, Carocci, Roma 2007 (English translation: *The IT Revolution in Architecture. Thoughts on a Paradigm Shift*, 2008) The phrase was originally pronounced by Bruno Zevi.

7 In A. Saggio, *The IT Revolution in Architecture. Thoughts on a Paradigm Shift* cited p. 47.

8 See chapter "Information" in A. Saggio, *The IT Revolution in Architecture. Thoughts on a Paradigm Shift.*

9 Ibidem p. 38.

10 A. Saggio, *The IT Revolution in Architecture. Thoughts on a Paradigm Shift*, cited p. 35.

11 One author who devoted many talks and books to the topic is Ken Robinson. For example *The Element: How Finding Your Passion Changes Everything* (with Lour Aronica). Viking, 2009 A good successful case is that one created in Great Britain by the "Studio schools" an English private organization part of The Young Foundation that created projects such as the Open University. A clear talk on this was on TED by Geoff Mulgan. In more technical terms this approach can also be referred to as "Project based learning".

12 See http://www.arc1.uniroma1.it/saggio/DIDATTICA/Cad/2006/Ass/FInale/ authors are students Agnese Canziani, Alessandra Cao, Chiara Conte, Giustino Di Cunzolo, Maria Ragosta. A. Saggio's Course on IT fifth year Sapienza University of Rome 2006.

13 I am referring to "Urban Voids" and "Urban Green Lines" teaching strategies on urban and architectural designs. The second project can be partially seen on my web pages and it is in publication. I talked on several occasions of Urban Voids, one in English is in "Paradigms in Architecture and Architectural Education" Conference: Assignments assuring Competences La Antigua Guatemala, ENHSA South America. www.arc1.uniroma1.it/saggio/Conferenze/Guatemala/

14 John Allen, "Buckminster Fuller's Synergetic Algorithm and Challenges of the Twenty-First Century" Speech delivered by for Buckminster Fuller Memorial at U.S. International University, San Diego June 4, 1996 http://www.biospheres.com/pubjabucky.html

15 From http://en.wikipedia.org/wiki/Vladimir_Vernadsky

16 Ibid.

17 http://en.wikipedia.org/wiki/Biosphere_2

18 An important source of study on this question is described in John Allen's in *Me and the Biospheres: A Memoir by the Inventor of Biosphere 2*, Synergetic Press, Santa Fe, 2009. The book provides the opportunity to follow in detail the history and conquests of this and other of Allen's projects. There are few architects and engineers, I'm sure, who know what I'm talking about, but thanks to the Web and Wikipedia in particular, in-depth information is available to all.

"John Polk Allen (born 6 May 1929, Carnegie, Oklahoma) [1] is a systems' ecologist and engineer, metallurgist, adventurer and writer [2]. He is best known as the inventor and Director of Research of Biosphere 2, the world's largest laboratory of global ecology, and was the founder of Synergia Ranch. Allen is a proponent of the science of biospherics.

Allen currently serves as Chairman of Global Ecotechnics, and a director of Biospheric Design and of Institute of Ecotechnics. He is a Fellow of the Royal Geographical Society, the Linnean Society, and the Explorers' Club.

In the early sixties, John Allen worked on regional development projects with David Lilienthal's Development Resources Corporation in the U.S., Iran, and Ivory Coast where he became an expert in complex regional development. Before that, he headed a special metals' team at Allegheny-Ludlum Steel Corporation, which developed over thirty alloys to product status. He has led expeditions studying ecology, particularly the ecology of early civilizations: Nigeria, Iraq, Iran, Afghanistan, Uzbekistan, Tibet, Turkey, India, and the Altiplano.

He studied anthropology and history at Northwestern, Stanford, and Oklahoma Universities, and served in the U.S. Army's Engineering Corps as a machinist. He graduated from Colorado School of Mines and received an MBA with High Distinction from the Harvard Business School. In the early 1960s, Allen headed a special metals' team at Allegheny-Ludlum Steel Corporation which developed over thirty alloys to product status, then he worked with David Lilienthal's Development Resources Corporation in the U.S., Iran, and Ivory Coast.

Under the pen name of Johnny Dolphin, he has chronicled his personal history alongside the social history of his many destinations in novels, poetry, short stories and plays. " from http://en.wikipedia.org/wiki/John_P._Allen

There is much literature inside and outside the web; it is interesting to note this section that is hosted by Columbia University itself http://www.columbia.edu/cu/21stC/issue-2.1/specmain.htm

19 Here is a bibliography http://www.biospheres.com/histfolsome1.html

20 http://www.studioargento.com/biosphere2/

21 *Architettura & Information Technology*, (eds. A. Saggio,) Mancosu, Rome 2011.