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Journal of Biourbanism (JBU) is a peer-reviewed international online journal of architecture, planning, and built environment studies. The journal aims at establishing a bridge between theory and practice in the fields of architectural, design research, and urban planning and built environment and social studies. It reports on the latest researches and innovative approaches for creating responsive environments, with special emphasis on human aspects as a central issue of urban study and architecture.

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Editorial

Eleni Tracada, PhD

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One particularly gratifying aspect of this issue is the presence of papers, which clearly refer to the main themes of Biourbanism.

The contributions of the authors for this first issue have been selected attentively in order to facilitate the beginning of refined discussions on these themes; the main intention is to generate a fine line upon which, either theoretical and/or scientific advancements on Biourbanism could be easily disseminated to vast expert audiences worldwide.

In his paper *Biophilia and Gaia: Two Hypotheses for an Affective Ecology*, Dr. Giuseppe Barbiero introduces Affective Ecology, which is primarily concerned with emotional relationships between human beings and the rest of the living world and also elucidates our affiliation to Mother Earth, Gaia (The Gaia Hypothesis), hence our natural relationship with Biophilia, our inherent inclination to focus upon life and life-like forms (The Biophilia Hypothesis).

In the second paper with the title *Green infrastructure planning: A contemporary approach for innovative interventions in urban landscape management*, Dr Ian C. Mell explains the importance of green infrastructure and how specific interventions according to this central approach to landscape planning in the UK, Europe and North America meet the challenges of population growth, transport and recreational needs with intend to support economic growth.
In their paper *How to investigate and improve legibility of urban projects to make them understandable for blind people? Contribution of Social and Behavioural Sciences Methods to Design for All Approach*, Ewa Kuryłowicz and Zuzanna Bogucka report and analyse legibility of urban space by referring to cognitive tactile maps, which can help blind people to move freely in certain spatial systems at design stage of Olympia Park in Berlin.

In Amiyo R. Ruhnke's paper *Stormwater management: Designing urban hydrological systems as infrascapes*, we learn about water infrastructure, which has been designed as networked natural systems, such as the self-organizing systems of mycelia fungi applied to a site in New Orleans in order not only to improve the quality of the open space, but also to link storm water management with engineering and urban design strategies (urban landscape as a continuous infrascape).

And finally in her *Sustainable refurbishment as a driving factor of urban regeneration*, Evgenia Budanova discusses advantages of the process of refurbishment and how this may affect the environment and urban fabric; this author has revised a successful case study of sustainable refurbishment of an industrial building in Moscow with the use of TAS software

to confirm that, a dwelling in that refurbished industrial building is now capable to consume less energy than a conventional one.

It has been a great pleasure to act as Editor in Chief of this issue and I should like to thank all the authors who have taken the time and effort to produce the published papers. However, I should also like to thank those authors who submitted papers, which did not attain the review process before the publication deadline. Therefore, I look forward to seeing also these papers published in our next issues in the near future.

I also believe that many interesting issues have been raised in each of the papers by all authors. Thus, I am convinced that all these issues are likely to get further debate. I should also like to encourage all readers and scholars to participate in additional written discussions and papers in the near future, if they wish, so that indisputable developments of the discipline of Biourbanism could take place at any time, as an incessant evolution of its principles and practices.

A note by the President of the International Society of Biourbanism

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As President of the *International Society of Biourbanism*, I'm happy to welcome the first volume of *Journal of Biourbanism*. I am grateful to the editor in chief, Eleni Tracada, to my colleagues Archana Sharma, Alessia Cerqua and Stefano Serafini as co-editors and, of course, to all the contributors, for this important achievement.

The *International Society of Biourbanism* was born in September 2010, by a group of international researchers, aimed at unfolding the theoretical basis for a new human-oriented built environment.

Many things happened during this first year! One of this is JBU, a key component of ISB activity. It aims to bring together theories, models and new design processes, but also wants to offer a platform for high-quality research, theory making, education, and practice.

We are to face several challenges, and the "battlefield" will be the city. In the last decades, we have attended some incredible historical events: world urban population has overcome the number of rural inhabitants for the first time ever; environmental problems, and climate change, have risen dramatically; strategic role of fossil energy is challenged, together with its economic and social implications; globalization changed the world order; digital technology entered our lives; etc. We cannot face these epical challenges by using obsolete tools, both in scientific as well as in policies terms.

In this scenario, JBU aims to represent something new. Its first task is about finding a new research methodology to be applied to the urban challenge.

Still today, the dominant paradigm handle the many problems associated with urban growth and global sustainability, as independent issues. Existing assessment models are based on outdated scientific patterns, that analyze cities and their features as separated and disconnected pieces. But cities are complex systems, whose infrastructural, economic and social components are strongly interrelated, and it's therefore impossible to understand them separately. The result is an ineffective policy, often leading to unfortunate and sometimes disastrous unintended consequences.

This disastrous result require a rethinking of the manner in which we analyze and plan the urban environments, and Biourbanism is our scientific answer. It is a science focusing on the urban environment, considering it as a hyper-complex living organism. It interacts with its

internal structure as well as with the external dynamics. This means that the urban body is composed of several interconnected layers of dynamic structures, all influencing each other in a non-linear manner. This interaction results in emergent properties, which are not predictable except through a dynamical analysis of the connected whole.

This scientific approach links Biourbanism to life and integrated systems sciences, like biology, ecology, statistical mechanics, thermodynamics, operations research. The similarity of approach lies not only in the common methodology, but also in the content of the results (hence the prefix "bio"), because the city represents the living environment of the human species.

Our goal, as Biourbanists, is recognizing the "optimal forms", defined at different scales (from the purely physiological up to the ecological levels) which, through morphogenetic processes, guarantee an optimum of systemic efficiency and for the quality of life of the inhabitants.

Biourbanism is based on the following groundwork: (i) Epistemic foundation and the needed scientific paradigm shift, (ii) New Life sciences, as biological roots of architecture and urbanism; (iii) Peer to Peer Urbanism, as an innovative way of conceiving, constructing, and repairing the city; (iv) Morphogenetic Design Processes, based on real recognition of "optimal forms", defined at different feedback scales (from physiological, to ecological), which, through morphogenetic processes, guarantee an optimal systemic efficiency, and therefore of the quality of life.

The above "corpus" shows a completely different way in which we consider and interact with the urban environment. From a scientific point of view, this open new fascinating research scenarios.

Towns and cities represent the living environment of the human species. Thus, it is fundamental create a design able to reinforce the urban structure according with our biological and neurophysiological requirements.

In this cultural context JBU aims to play a leading role where, research workers and scholars, from several fields such as mathematics, physics, biology, neurophysiology, architecture and urbanism, can contribute for a better urban environment and a future full of hope for humankind.

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Part A – Peer-reviewed papers

Biophilia and Gaia: Two Hypotheses for an Affective Ecology

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ABSTRACT

Affective Ecology is a new branch of ecology concerned with emotional relationships between human beings and the rest of the living world. The basic instinct that guides the evolution and maturation of a well-tuned relationship with the living world seems to be biophilia, our innate tendency to focus upon life and life-like forms and, in some instances, to affiliate with them emotionally (*The Biophilia Hypothesis*). Our feeling of a deep connection to Nature, our sensation of being a child of Mother Earth, of Gaia, is probably an instinct and it is present in all human cultures, including those more technologically advanced, where a scientific understanding of the planet's living nature has been developing to an ever more advanced level (*The Gaia Hypothesis*). Nevertheless, within our artificial society, now distant from the natural world, we are running the risk that our biophilia is not becoming adequately stimulated in order for it to flourish as naturalist intelligence, the ability to take care of and subtly interact with living creatures. On a brighter note, we are discovering that Gaia continues to affect us on a deep psychological level, activating our involuntary attention (fascination) and favouring the restoration of our attentional capacity. We can all learn to respond to the call of Gaia and the natural world, to refine our senses and our mental capacities through the practice of active silence (mindfulness meditation); an engagement that seems to be particularly efficient in re-establishing our personal connections with Gaia and the living world.

Keywords: Active Silence Training (AST); Affiliation; Attention Restoration Theory (ART); Directed Attention; Empathy; Fascination; Mindfulness Meditation; Open Attention.

The environmental crisis is an outward manifestation of a crisis of mind and spirit. There could be greater misconception of its meaning than to believe it concerned only with endangered wildlife, human-made-ugliness, and pollution. These are part of it, but more importantly, the crisis is concerned with the kind of creatures we are and what we must become in order to survive.

(Lynton K. Caldwell)

AFFECTIVE ECOLOGY

The urgency posed by the big environmental issues requires a global reaction from humanity that is both rapid and adequate to defend the natural world (Stern 2007; IPCC 2007; Rockstrom et al. 2009). Nevertheless, despite our ever increasing knowledge of the global ecology, only a minority are truly motivated to modify their behaviours in order to face the environmental challenges. We are talking about well-informed moral people, for whom the knowledge about such problems is motivation enough to drive them to take action for ethical outcomes (Schultz 2001). For the majority of people, on the other hand, an exclusively rational and cognitive approach to the big problems regarding the environment is often insufficient to motivate them to take preventative or remedial action. Of consequence, various authors have warned of the necessity to bring emotive and affective associations into discussions about conservation (Saunders 2003), environmental education (Wilson 2006) and sustainability (Colucci Gray et al. 2006; Camino, Barbiero & Marchetti 2009).

To consider emotive and affective connections between human beings and the rest of the living world opens up a vast field of interdisciplinary research that teeters on the boundary that lies between biology and psychology. Indeed, these types of connections to which we refer have their phylogenetic roots in the evolutional history of humanity and can therefore be the subject of biologists, or reflect the ontogenesis of the human psyche and therefore be the subject of psychologists. Epistemological, linguistical and methodological differences exist between biology and psychology that cannot be underestimated. Nevertheless, understanding how a connection between a human being and an animal, a plant or a natural environment is established, developed and consolidated is of fundamental importance for environmental education that aims to permanently modify the behaviour of people. *Affective ecology* is focussed upon this area of research (Barbiero et al. 2007b; Barbiero 2009): it is '*affective*' because the capacity of the human species *to bond with* is only in part genetically programmed, and instead depends to a large degree upon the development of psychological potentials that themselves depend more upon cultural than genetic contexts (Bell, Richerson & McElreath 2009); and '*ecology*' because ecology is the science of phylogenetically determined connections. Affective ecology is proposed as a complementary tool to cognitive ecology that conveys knowledge via rational reasoning, exploring new channels of comprehension about (and of communication with) the living world – that knows how to make wise use of the affective and emotional competences of people. To form a more precise intellectual framework of affective ecology, I want to unit two scientific hypotheses that could constitute its scientific base: the biophilia hypothesis, proposed by Edward O. Wilson (1984), and the Gaia hypothesis, created by James Lovelock (1979). Two scientific hypotheses that presume a strong affective component – explicit in the biophilia hypothesis and implicit in the Gaia hypothesis – and it is just this characteristic that makes their combination particularly interesting to us.

THE BIOPHILIA HYPOTHESIS

Biophilia Framework

According to Edward O. Wilson, biophilia is «our innate tendency to focus upon life and life-like forms and, in some instances, to affiliate with them emotionally» (Wilson 2002, p. 134). Humanity, over the course of our evolution, would have developed a set of phylogenetically adaptive learning rules that mould our relationships with the natural world, even today (Wilson 1993). If this hypothesis is correct, the biophilic instinct would find its expression in a) *attention* – the capacity to let oneself be fascinated by natural stimuli, and b) *empathy* – the capacity to emotively affiliate with the different forms of life, or, as more precisely suggested by Silvia Bonino when referring to one-way empathetic engagement with non human life, *differentiated participation*. Thus, attention and empathy would constitute the two central constructs of biophilia and, at the same time, the two mental faculties that characterise the human instinct to love and care for Nature, faculties that should therefore be adequately cultivated.

Attention

Psychologists generally agree that attention can be defined as the process by which some elements of sensory information are encoded and elaborated whilst other aspects of the sensory reality are neglected (Valenza & Simion 2002). Our senses continually receive an enormous mass of stimuli and information about the external and internal environments that is elaborated by the subcortical centres without us being aware. Only a small part of this information reaches the cerebral cortex and engages with the consciousness, and thus gaining our attention. Attention focuses on only some aspects of the world that for some reason appear to be important. Our faculties – i.e. memory, deduction, risk evaluation, etc. – concentrate and attend towards the origin of the stimulus. Attention is phylogenetically adaptive and has evolved in man in response to the needs of basic survival, developing configurations of characteristic neural networks, corresponding to the diverse modalities with which attention manifests (see e.g. Parasuranam & Davies, 1984; Parasuranam, 1998). Here, we will consider two types of attention: directed attention and open attention.

Directed attention is the capacity to activate a state of alertness or to consciously direct ones attention towards the object that provoked it. It is a type of functional attention which serves that that we are doing and that requires mental effort to be maintained with time. It is the form of attention that one needs to carry out tasks or to finish a job. It is the form of attention that we can define as passive and subordinate because it responds to external stimuli, it is attracted to them and it can become prisoner of them (Pensa 2002).

Open attention, on the other hand, is a state of vigilant consciousness, active because it is attention in itself, free and independent of external stimuli. A form of attention that takes care of "here and now", that attends new insights, as in the sense of the Buddhist *yoniso-manasikāra* which implies exactly this type of attention, where *yoni* indicates the maternal womb (Pensa 2002): a form of attention that generates new awareness, and becomes a permanent mental state.

Directed and open forms of attention are not coextensive mental states: directed attention limits open attention. However, directed attention is important for establishing open attention. For example, suppose you were to take up a new sport that you had never done before; the movements do not come easily, they are awkward and you feel cumbersome performing them. We therefore apply our will to focus our directed attention on the exact execution of each movement until, with practice and patience, the movement comes naturally. This liberates the need for directed attention, leaving space for open attention, that Simone Weil calls "true" attention (Weil 1966). Thus open attention has a systemic nature: the athlete does not pay attention to the sequence of necessary movements anymore (directed attention), but to how these movements equilibrate between themselves.

Affiliation

According to Ursula Goodenough, the phylogenetic origin of the sentiment 'to affiliate with' resides within the neuronal networks involved in the contemplation of our profound genetic affinity with creatures of other species. It seems that these neuronal networks evolved via the exaptation route from networks that guided our maternal and paternal instincts, networks that also generated emotions like love, care and the instinct to protect. The root of altruism and of responsibility, in the literal sense of the term *to marry (sponsum) things (res)*, has its origin in «our capacity to experience empathy with other creatures and respond to their concerns as our own» (Goodenough 1998, p. 127).

The sentiment 'to affiliate with' seems, from this perspective, like a particular manifestation of empathy, here intended as the capacity to feel, to understand and to share thoughts and emotions with another. From an ontogenetic point of view, empathy evolved with the psychological development of the child. Around 3-4 years of age, a child experiences his/her first form of *empathy for participatory sharing* that will accompany him/her for all of childhood. In adolescence, with the development of an ever more sophisticated cognitive capacity, the ability to feel and share the thoughts and emotions of others extends to the comprehension of entire social groups *(empathy for general conditions*; LoCoco, Tani, & Bonino 1998) and (in an extended form) to participate in the "emotions" and expressivity of animals and the sacrality of vegetable life (Hill 2000) and certain natural landscapes (Naess 1976). Thus empathy transforms in this way into *differentiated participation* or *asymmetric empathy* of the different forms of life and natural objects (Barbiero 2007a). We talk about differentiated participation (or asymmetric empathy) because the real sense of empathy, by definition, can only exist between human beings that reciprocally divide the capacity to understand and share *human* emotions. The relationship that is established between a human being and an animal cannot therefore be of empathetic form because, even when a non-human living being is able to perceive and correctly tune to the emotive state of a human being, it is not able to share the experience. Indeed, many animals perceive human emotions, but they experience them in a completely different way. The reverse is also true: even though it can be useful in certain contexts (with children and the elderly), human beings should avoid the psychologically regressive confusion of projecting human sentiments onto a non human living being.

BIOPHILIA AND NATURALIST INTELLIGENCE

Naturalistic intelligence is the eighth manifestation of human intelligence according to the classification posed by Howard Gardner in his *Multiple Intelligence Theory*. It is defined as the ability to connect, on a profound level, with non human living beings and to appreciate the effect that such relationships have upon us and our external environment (Gardner 1999). This form of intelligence requires a developed sensory ability with which to perceive living organisms, the capacity of logical reasoning that allows us to distinguish and classify living organisms on the basis of certain logical parameters, a particular emotive sensitivity toward all that is "natural" and, finally, a certain existential knowledge that allows us to link all these qualities together on the basis of experience of a spiritual nature (Gardner 1999). If biophilia, as stated above, is a set of phylogenetically adaptive learning rules, it could constitute the physiological basis and the psychological potential from which naturalistic intelligence emerges.

However, as observed by Richard Louv, if children are not allowed to have the opportunity to develop an adequate relationship with nature, biophilia is not stimulated and naturalistic intelligence atrophies, causing damage to both the physical and psychological development of the child, which Louv defines, on the whole, as "nature deficit disorder" (Louv 2005; Charles & Louv 2009). Thus, it is necessary that the pedagogy of naturalist intelligence reverts to its original vocation, educating people to recognise the peculiarities of the living state of the various forms of matter (Buiatti & Buiatti 2001) in its manifestations of autopoiesis (Maturana & Varela 1980), negentropy (Schroedinger, 1942) and mental processes (Bateson, 1980). Life is a natural phenomenon, different and unique with respect to all the rest (Capra 1996; Buiatti & Buiatti 2008).

Who is able to recognise – intuitively or intellectually (by which, it is not important) – the peculiar harmony of each living organism cannot fail to experience a profound sentiment of marvel and of reverence for the mystery of matter that is able to transform itself into something living; and the fact that each organism – even a clone! – is actually unique and unrepeatable. Life, in this sense, is truly sacred (Bateson & Bateson 1987; Goodenough 1998). Thus, a theoretical framework is needed that can account for each element and that makes sense, not only of the living taxonomy, for example, but also of the great biogeochemical cycles and the sentiments of affiliation that we feel «for our Sister, Mother Earth» (Francis of Assisi). A theoretical framework is needed that meets the scientific standards of the XXI century, and that excites and inspires. Gaia, Mother Earth, a universal myth, yet also a contemporary scientific hypothesis, provides the answer. An efficacious pedagogy of naturalistic intelligence cannot but start here.

THE GAIA HYPOTHESIS

The Gaia Framework

The rocks, the minerals, the water, the air, the earth and its visible inhabitants, the fungi, the plants, the animals: each creature, living or not, can speak to us, can help us feel at ease within our common home, the Habitable Earth (*Gê oikouméne*). We are all children of Gea

(Γῆ), or Gaia (Γαια), children of a very long and uninterrupted evolutionary history. We feel that we belong, not only to the human race, but also to the biosphere itself, and we can empathise deeply with the sacredness of each living form (Goodenough 1998). Little by little we re-discover our ecological selves, being part of our deepest self (Naess 1976). We do not need to put excessive demands upon our linguistical/verbal or logical/mathematical intelligence with discussions about environmental education or diagrams of the greenhouse effect because it is the *locus naturae* that educates our naturalistic intelligence (Hill 2000). And it will be our naturalistic intelligence that stimulates the manifestations of our other forms of intelligence, in all their shades, day after day more cognitive and affective (Goleman 2009) to become aware of our responsibility towards ourselves and to all creatures, a responsibility that derives from being the species that knows the other species (Volk 1998).

Gaia as a universal myth

Myths are timeless and they express with their archetypal contents some fundamental themes of humanity with universal validity that cannot be conveyed using rationality alone. Mother Earth is without doubt an archetype deeply rooted into our psyche. The concept of the Earth as a Mother is present in virtually all cultures and dates back to the Neolithic age: the idea is that the Earth is a sort of womb for life (Gimbutas 1989). In ancient Greek mythology, for example, Gaia is the starter of life: the Olympic Gods and all living creatures descended from Gaia (Koreny 1958). She is also the Roman *Mater Tellus* (Koreny 1958) and *Hel* in Norse mythology (Monaghan 1981). She is a mother Goddess that renews with each season (she is always a virgin and always fertile) and she knows the mysteries of life and death: she is a Goddess of knowledge. Over the course of the centuries, this Goddess has tended to be personified into ever more distinguished female figures, each one of which conserves an attribute of the original Goddess. For the ancient Greeks, the Goddess that best assumes the form of Gaia is Demeter, and her name (Δημήτηρ) again converts back to Mother Earth. Demeter, together with her other identities, Persephone and Kore, is at the centre of the Eleusinian Mysteries, the ancient religious rites that celebrated the cyclic seasons of life: Persephone's Winter, Persephone being the wife of Ade and Queen of the Underworld, and the awaking of Kore in the Spring, Kore being the fertile Goddess of vegetation (Koreny 1958). It is possible to retrace the same myth structure to the Celts, with the epic deeds of Eire and Fodhla (Monaghan 1981), and even in the patriarchal Christian world, where the virgin and mother "Goddess" incarnates into the historical figure of Myriam of Nazareth who, starting from the Third Ecumenical Council of Ephesus in 431, became to be known as *Theotókos*, the Virgin Mother of God.

Gaia as a scientific hypothesis

The myth of Gaia was borrowed by James Lovelock (1979) to illustrate a scientific hypothesis that describes the dynamics that make the Earth a peculiar place to host life. The Gaia hypothesis was for a long time a controversial argument, in part because experimental verification was difficult to obtain (Kirchner 1989) and in part because the more orthodox academic culture does not like such a merger of science and myth (Margulis 1998). However, it is now commonly accepted that the Earth is a system characterised by the phenomenon of emergence (Schenider 2001). This presumes that life has a significant effect upon the

environment (*influential Gaia*), at least upon the Earth's surfaces and the atmosphere (Kirchner 1989; Kirchner 2002). In turn, the environment exerts its influence by limiting the evolution of the biosphere via Darwinian processes (Lenton 1998).

It is more difficult, however, to establish whether the biosphere influences the abiotic world in a stabilising way. If it were so, negative feedback loops should prevail in the dominant connections between biota and the physical world (*optimizing Gaia*). Life, in other words, would not only condition some chemical-physical variables in such a way that they adapted to life (for example, mean atmospheric pressure at 1 bar and the average surface temperature between 0° e 100° C, parameters that allow water to be conserved in the liquid state), but it should also be able to cope with oscillations of these variables such that it always returns to the reference values after a global perturbation. Overall, what one observes in reality is behaviour of Gaia that is both homeostatic, where negative feedback loops effectively prevail, and homeorhetic, where positive feedback loops prevail (Barbiero 2005).

The biogeochemical cycles of our planet seem to be fundamentally homeostatic: the feedback loops have a negative sign, that is, they tend to inhibit the perturbations from altering the overall structure of the system. In principle, however, it is possible that one or more positive feedback loop is established within the cycle; loops where the product of a reaction amplifies rather than inhibits the sequence of successive reactions, triggering a cascade process. A cascade process by nature tends to modify the equilibria consolidated in an irreversible manner and the system becomes unstable, remaining as such until a new point of equilibrium is attained (homeorhesis). The history of the Earth is constellated with episodes that have upset long-standing homeostatic equilibria, such that these points of discontinuity are used by academics to divide the history of the Earth up into geological eras. From the Proterozoic eon onwards, the protagonists of many of these points of discontinuity are diverse forms of life that inhabited the planet (Schwartzman 1999). One example is the transformation of the terrestrial atmosphere from a reducing to an oxidising one caused by photosynthesising organisms. This, not only contributed to changing the planet's climate, by cooling it down, but they started to release molecular oxygen into the atmosphere that revealed to be lethal for life on Earth. For some time, the planet managed to absorb the oxygen, mostly via the easily oxidised minerals contained within the rocks, but once these deposits were saturated, the free oxygen in the atmosphere destroyed the layer of anaerobic organisms that covered the Earth (Schwartzman 1999). Following this ecological disaster, the terrestrial atmosphere never again favoured anaerobic life, although the new equilibrium attained permitted the evolution of eukaryotic cells (Volk 1998; Margulis 1998).

Whatever the true nature of Gaia may be – influential or optimising –, the hypothesis formulated by Lovelock gave rise to a rich and heuristic field of study: Geophysiology, which considers the biosphere and its matrices (atmosphere, geosphere, hydrosphere) as a single super-organism *sui generis* (Kump, Kasting & Crane, 2004).

GAIA FASCINATION RESTORES HUMAN BIOPHILIA

Gaia is not only a legend and a scientific hypothesis; Gaia is an essential element of our lives. We are discovering that Gaia affects us on a deep psychological level – as only a true mother would – activating our involuntary attention, fascinating our senses and favouring the

restoration of our attentional capacity. If this is true, we stand before a crucial issue that needs to be addressed in its entirety: here, Gaia is the *active* subject, while humanity receives physical and *psychological* nourishment. Modern man is used to considering himself to be at the centre of the Universe. He tends to believe that he is the sole driving force, for better or for worse, of his own destiny. Here, we are dealing with a totally new perspective, which is much more humble: we depend upon the integrity of Gaia: as stated by Francis of Assisi in his *Laudes Creaturarum* (1224), Mother Earth really sustains and manages us, not only physically («et produce diversi fructi»), but also on the psychological («con coloriti flori et herba») level.

The Attention Restoration Theory

The primary question of my research is thus: why and in what way is attention influenced by certain natural environments? In the quest to answer this question, I have become greatly interested in the Attention Restoration Theory developed by Stephen Kaplan, psychologist at University of Michigan, particularly about the restorative power of fascination (Kaplan 1995) and mindfulness meditation (Kaplan 2001).

Fascination

Kaplan distinguishes two forms of attention: directed attention and involuntary attention, or fascination. The first form, we have already discussed above. To Kaplan, directed attention, in its essence, can be defined as the capacity to inhibit concurrent or distracting stimuli while carrying out a task (Kaplan 1995). When directed attention is subject to intense and prolonged use, it becomes exhausted and mental fatigue occurs: the subject is more easily distracted his/her behaviour becomes more frequently impulsive and hostile.
Involuntary attention (James 1892), or fascination, is a form of effortless attention, resistant to fatigue (Kaplan 1995). It permits directed attention to rest and regenerate until it returns to normal efficiency levels. Fascination can trigger open attention inasmuch as it emerges from the performance of processes (for example, from play, but also from listening to or telling stories, or problem solving) or by simply surrounding oneself with into wild natural environments perceived as reassuring and regenerating (*wilderness Gaia*).

Mindfulness

Mindfulness meditation is a psychological practice with its roots in the spiritual traditions of Buddhism (Siegel, 2007), and from which various methods used in stress reduction (Kabat Zinn; 2005) and diverse psychological therapies have been derived (for a recent review, see Horowitz, 2010). In its essential form, mindfulness meditation offers the opportunity to experience suspended individual moments in time from the multiple auditory and visual stimuli received and to enter into relationship with one's interior space (Freire, 2007). Mindfulness meditation requires the practitioner to empty his/her mind of the flow of thoughts that tend to activate directed attention, creating in this way the right conditions such that open attention can manifest (Pensa 2002).

Kaplan retains that a person, even with modest training in meditation, could obtain great benefits in his/her capacity to regenerate directed attention from practicing mediation, even if the environmental context has little or no regenerative properties (Kaplan 2001). In some way, mindfulness meditation may have a substitutive role to that of fascination of the natural world.

Kaplan's hypothesis (known as the 6th hypothesis) opens up new perspectives: if fascination of Gaia regenerates directed attention, establishing in this way a point of contact with the human psyche, symmetrically the human psyche, via mindfulness meditation could establish a point of contact with Gaia, or at least with some of her epiphanies. Indeed, *wilderness Gaia* and *mindfulness meditation* require the human subject to "let go" of directed attention and to predispose oneself to open attention.

Active Silence Training

On these bases, Dinajara Doju Freire, Maria Ferrando and I developed *Active Silence Training* (AST), an educational scheme designed specifically for primary school children (Barbiero et al 2007b). The AST is constituted of fascinating games that aim to stimulate biophilia in children, enhancing properties of both attention and empathy. For this reason, the AST is divided into two modules: *Cooperative Play* (Bello, Bo & Ferrando 2002) and *Mindful Silence* (Freire, 2007). The *Cooperative Play* module is constituted of games that encourage the children to cooperative between themselves in order to stimulate their sense of empathy (Jelfs, 1982; Bonino, 1987). The *Mindful Silence* module is constituted of games that introduce mindfulness meditation to the children, thus stimulating their faculty of attention (Kaplan 2001; MacLean et al. 2010).

Experimental data

To enable biophilia to flourish in each child, we need to stimulate his attention and his sense of empathy. The AST is the instrument that we have created to attain this objective in children that pass a large part of their time in urban environments with poor regenerative powers. Although the AST was performed in many primary schools in North and Central Italy, all the experimental observations reported here were taken at the Istituto San Giovanni Bosco delle Figlie di Maria Ausiliatrice, a primary school in Aosta (Italy), in order to present a socially homogenous group of children and to follow them over the course of their five primary school years.

Both physiological and psychological parameters were taken into consideration in the study. Regarding the former, heart rate and arterial blood pressure were assessed – indicators of the state of relax of the children (Barnes et al. 2004; Black, Milam & Sussman 2009), and for the latter, the *Continuous Performance Test* (CPT, Cornoldi, 1996) was primarily used to evaluate the regenerative capacities of attention in the children. This version of the CPT is a paper and pencil test that measures sustained attention. The subject is required to spot a triplet of the same repeated letter within a very long string of letters. The CPT is a brief and conceptually simple test, but nevertheless somewhat tiring for primary school children. It is a validated measure of sustained attention (see e.g. Corkun 2008). The CPT measures

sustained-directed attention as well as the capacity to inhibit or block out other stimuli. In our CPT, a triplet of letters was presented to the subjects for three test-trials whereby the order in which the same letters appear changes for each trial as does the size of the letters and the spacing between them. No cognitive function is involved whilst performing the test as the order of the letter string is casual and without sense; however, the subject is required to maintain directed attention. The CPT allows us to measure four variables: the number of correct replies, the number of incorrect replies, the number of times no reply is given, and the time to complete the test. In this way we have been able to assess to what extent and after how much time children are able to regenerate directed attention by means of *active silence* (Barbiero et al. 2007b).

In a first phase, we compared the regenerative capacity of the AST with that of the children's habitual recreational break between lessons (playtime); we obtained evidence that the AST is much more efficient than their usual playtime in regenerating attention in the children at school (Barbiero et al. 2007b). Next, we compared the two modules of the AST, the Cooperative Play and the Mindful Silence modules; we discovered that the Cooperative Play module produces immediate but transient regenerative properties of attention, while the practicing of Mindful Silence regenerates directed attention more slowly but the effects are longer-lasting (Berto & Barbiero, manuscript submitted). Finally, we compared the AST in class with the fascination of nature. We took the children on an explorative nature trail within the woods, incorporating story-telling and song such that the children could fully immerge themselves into this environment with absolute serenity. We were not surprised to observe that following this experience of nature their assessed performances of directed attention were comparable or better to those achieved after performing the *active silence* exercises in the classroom (unpublished data); this result was also confirmed by the outcome of the children's version of the Perceived Restorativeness Scale (Pasini et al. 2009), a test for assessing how the regenerative potential of an environment is perceived.

Evocative Suggestions

If our observations are confirmed, we can conclude that:

1) Some natural environments are able to stimulate fascination in children in such a way that enables directed attention to rest and regenerate.

2) Biophilia could exert an evolutionistic influence that goes beyond the memory of our past in the savannah (Balling & Falk 1982), affecting both directed attention and concentration. Thus, biophilia could represent a relevant evolutionistic advantage (Barbiero 2010).

3) If the capacity to regenerate depends on certain natural contexts, one might expect that the destruction of the Earth's wildernesses, in addition to the more obvious serious consequences, would have a detrimental effect upon the ability of our future generations to mentally regenerate in a full and complete manner. In particular, the studies of environmental amnesia come to mind (Kahn, 2007).

4) If, of the various natural contexts, those of intense natural beauty are not other than the epiphany of Gaia, then, in one sense, it is Gaia that regenerates our ability to attend. Thus, the veneration of the ancient populations for Mother Earth (Gimbutas 1989) should not be considered a naïve rite, but as an act of gratitude for that that is the power to regenerate.

5) Finally, I turn to definition of biophilia, «our innate tendency [...] in some instances, to affiliate with [life forms] emotionally» (Wilson 2002, p. 134). Wilson uses – and I believe not by chance – the verb "to affiliate". The etymology of the word "affiliate" is Latin (*ad filius*) and means "son of", thus implicitly indicates a relationship with a "mother". If Gaia is the scientific epiphany of Mother Earth, then Gaia is "mother" and humans are literally her "sons". It is clear that of all the empathic relationships, that existing between mother and child is one of the most profound and special. What is more, could the mother-child model of an empathic relationship be that that best encapsulates the empathic relationship between Gaia and mankind? Even though there are many scales that measure mother-child empathy, we have not been able to identify one yet that could be used together with the AST, but the investigational road ahead is without doubt promising.

AFFECTIVE ECOLOGY AND HUMAN SPACES

Over recent years, biophilia has more frequently been taken into consideration in studies, hypotheses and practical proposals regarding the designing of human spaces in order to optimise human welfare, performance, etc. (see e.g.: Kellert 2005; Tai et al. 2007; Kellert, Heerwagen, & Mador 2008; Salingaros et al. 2009). Though being a good starting point, biophilia is, however, only a quality of the human mind that requires an adequate relational context and Gaia to be expressed, or, better still, one of her innumerable epiphanies can provide the right partner to enable biophilia to flourish.

Regarding affective ecology, I propose the following food for thought:

1) Biophilia is a collection of learning rules which depend upon the mental faculties, attention and empathy. A Biophilic project should consider i) fascinating environmental contexts to diminish the use of directed attention and favour open attention, and ii) the most appropriate spaces for human interactions to favour empathetic contact between human beings and between human beings and the natural world (Zammit et al. 2010).

2) Fascination is a relational process where man is the passive actor and the various epiphanies of Gaia react directly upon the human psyche. However, fascination is limited by the experience that each person has of the natural world. A biophilic design should dedicate space for manifestations of wilderness Gaia that are compatible with a real experience of wilderness for the user (Kaplan 2001).

3) Open attention can connect the human psyche to wilderness Gaia. A biophilic design should, therefore, provide spaces for retreat and solitude where the perception of the world's beauty merges with one's more intimate spirituality (Ouellette, Kaplan & Kaplan, 2005).

CONCLUDING REMARKS

Like many conceptual instruments of the life sciences, the biophilia hypothesis and the Gaia hypothesis do not possess the status of 'theory' in the strict sense of the word: that is, they do not possess a predictive power derived from their logical-deductive structure. However, many lines of evidence support their real consistence, insomuch as that today the biophilia hypothesis and the Gaia hypothesis together can be considered as a collection of inductive models with great heuristic value for the environmental sciences. In their flexibility, the Gaia and biophilia models conserve all the complexity of the living world (Capra 1996), with networks of connections never completely closed and boundaries never completely defined, as is life (Camino & Barbiero 2005). The Gaia hypothesis and the biophilia hypothesis offer to the scientific community a new way of contemplating the living world, where experimental observation becomes a tool for dialogue between different perspectives (Benessia, Barbiero & Camino 2006) and where a verbal language is favoured that is better adapted for describing the dynamicity of the processes than a nominal language that tends to crystallise in definitions that for their nature are in continual evolution (Dodman, Camino, & Barbiero 2008).

If ecology is the science of the relationships between living organisms and their environment, the relationships between human beings and the rest of the living world should receive particular attention. Here, affective ecology emerges: the study of the affective *and* cognitive relationships that human beings establish with the living and non living world. It addresses emotions that become sentiments, and intuitions that become knowledge. Sentiments and knowledge are not juxtaposed, they interchange however and collaborate. Read Nature with an open heart, listen to Nature with a ready mind: this is the correct nourishment for the healthy growth of naturalistic intelligence.

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Green infrastructure planning: a contemporary approach for innovative interventions in urban landscape management

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ABSTRACT

Green infrastructure has become established as the central approach to landscape planning in the UK, Europe and North America over the past decade. Bringing together a number of disciplines to form a coherent landscape resource based approach to environmental management. By assessing its utility and value this paper addresses the development of this approach in policy, practice and examines its successes and failures. Reviewing alternative approaches that green infrastructure interventions take to meet the challenges of population growth, transport and recreational needs and supporting economic growth is therefore an important assessment. This is discussed in terms of the direction that current and future green infrastructure planning policy is being presented in. Despite the extensive use of its principles in landscape planning in the UK, Europe and North America additional data is required if it is to be embedded fully in policy at the appropriate scale.

Keywords: Green infrastructure, green urbanism, landscape management, urban planning.

INTRODUCTION

Managing the urban landscape is a process fraught with difficulties and conflicting agendas. There is a perceived need in government, articulated through policy, to provide adequate and sufficient housing, transport infrastructure and support commercial development to secure the prosperity of a city or economy. However, this directly contributes to trade-offs between economic needs and the support for ecological resources management. Due to the lack of informed valuations of environmental resources, financially as well as socially, ecological resource bases in urban landscapes are often marginalized. Over the last decade green infrastructure has developed as an approach to landscape planning that addresses the fragmented thinking associated with urban development. The green infrastructure planning agenda brought together planners, ecologists, architects and developers and proposed a

holistic, and functional understanding of the ecology of urban environments. By proposing that ecological resources should form the fundamental building blocks for landscape management the supporters of green infrastructure have advocated its utility to meet a number of planning issues (Benedict & McMahon, 2006; Mell, 2009).

Green infrastructure has been discussed as providing theoretical, policy and practice led solutions to the continued demands placed upon urban areas. Drawing on a number of principles from Landscape Ecology it promotes the maintenance of ecological resources within connected networks of green spaces, watercourses and greenways. Green infrastructure planning also supports the thinking reviewing sustainable transport by promoting alternative solutions to the private motorcar. Furthermore, it directly addresses the need to view urban landscapes as a platform for green investments in the form of street trees, green roofs or in more formal parks and public open spaces (Tyrväinen, 2001; Castleton *et al.*, 2010). The overarching message presented by green infrastructure practitioners is its adaptive capacity to address current issues (housing or anti-social behavior) whilst proposing innovative, and often community led initiatives to address them (Benedict & McMahon, 2006; Tzoulas *et al.*, 2007).

The aim of this paper is to examine the role green infrastructure holds in urban planning practice. Given the potential development opportunities proposed above, green infrastructure is discussed as offering solutions to planning issues at a number of scales. The following sections address how planners and practitioners are working to meet the challenges of growth and development using adaptive *green* approaches to landscape management. This includes assessments of the role of water, brownfield regeneration and development in high-density areas. CABE Space (2009), Gill *et al.* (2007) and Williamson (2003) have all discussed the approaches used by planners to create responsive environments, and examine how human interactions with this process are central to the success of green infrastructure investments. They also reflect on the nature of these discussions within landscape planning policy, highlighting where limitations occur in the translation of green infrastructure policy into practice.

GREEN INFRASTRUCTURE: A GLOBAL CONTEXT

Green infrastructure can be considered a relatively new research agenda. Developed over the last decade it has become the most prominent contemporary approach to landscape planning. Whilst the focus of green infrastructure development differs spatially and geographically, there is a growing consensus assessing what it can achieve, and how it should develop. Table 1 highlights the variation in focus of green infrastructure programs suggesting that opportunities present themselves whereby *greening* projects labeled as ‘green infrastructure’ could provide more effective or joined-up approaches to landscape management (Benedict & McMahon, 2006). The areas proposed in Table 1 are derived from an extensive analysis of the green infrastructure, greenways, community forestry, urban planning and design literature produced in the UK, Europe and North America. The understanding of green infrastructure outlined also draws on its reporting and use in policy produced at a national, regional and sub-regional scale. A review of these discussions can be found in Mell (2010) Primary research undertaken with a broad range of practitioners also informs this discussion.
Reference though should be made of the differences in green infrastructure compared to other, i.e. greenways, planning agendas. green infrastructure has adapted the principles of greenways

(Little, 1990; Fábos, 2004), expanding landscape debates from an analysis of linear or isolated green space management towards a multi-functional and network approach. The utility of green infrastructure in policy and practice thus lies in its ability to integrate the principles of connectivity, multi-functionality and strategic management proposed by greenways to support a more holistic planning approach (Weber *et al.*, 2006; Tzoulas et al., 2007). Moreover, although green infrastructure uses the approaches developed historically in landscape management it applies further characteristics from Landscape Ecology and urban design to focus its use in current planning practice (Mell, 2010a).

Table 1. Focus of green infrastructure planning in the UK, North America and Europe

UK	**North America**	**Europe**
i. Community forestry ii. Sustainable urban design iii. Urban renaissance iv. Sustainable communities v. Climate change adaptation vii. Healthy lifestyles and landscapes viii. Biodiversity and conservation	i. Climate change adaptation ii. Micro-climate control in urban areas iii. Biodiversity conservation and assessments iv. Sustainable urban design v. Sustainable drainage systems vi. Smart Growth vii. Water resource management	i. High density urban development ii. Mobility iii. Climate change mitigation and adaption iv. Sustainable urban design

The variation shown in Table 1 highlights the differences in the historical application of green space planning. The UK established a system that supports ecological, economic and social development. In Europe, due to the compact nature of cities planners have followed an ecological-social approach. Whilst in North America, the fragmented approach to landscape planning, in both policy and practice led to a less well-defined approach to landscape planning. North American research though has focused primarily on water resource management (Dunn, 2010; Fábos, 2004).

The role of green infrastructure in landscape management though is dependent on a number of variables; location, assessed need, governance structure (of policy and funding) and the existing resource base. It does not offer a singular or uniform process that can be applied to all environments. The specific locational context is therefore integral in the application of green infrastructure to ensure that interventions do not negatively impact the landscape. Consequently, green infrastructure has infiltrated the process of policy development by emphasizing its value to a wide range of landscape professionals. This has been achieved by using the language associated with Landscape Ecology, sustainable development and green space planning to express its principles in ways planners and developers can utilize. Through this process green infrastructure practitioners have been able to promote a complex amalgamation of ideas within a coherent and pragmatic approach to green investment. This has brought together an understanding of ecological networks (Ignatieva, Stewart & Meurk, 2011), connectivity (Kambites & Owen, 2007) and multi-functionality (Natural England, 2009) with the sustainable development agenda (Lindsay et al., 2001) in order to frame the innovative and spatial aspects of green infrastructure delivery (Madureira, Anderson & Monteiro, 2011).

In the following sections a range of case studies are presented exploring the value of green infrastructure in urban landscapes. Each highlights the utility of green infrastructure outlining how it can act as a conduit between planning policy and practice. The assumptions made will be drawn upon in the final sections of this paper promoting a joined-up green infrastructure approach to planning that links policy with practice.

URBAN GREEN INFRASTRUCTURE: AGRICULTURE, FORESTRY AND GREENING PROJECTS

The value of urban greening projects to well-being, economic growth and ecological sustainability is well researched. However, there is a lack of economic evidence supporting investments in green infrastructure compared to *grey infrastructure*. Planning for green investments at a local or neighborhood scale though can provide proportionally greater benefits due to the proximity of residents to investment sites. The rise of urban agriculture, community tree planting and green retro-fitting in urban areas are all ways that green infrastructure can contribute positively to urban sustainability by promoting a localized process of resource valuation.

Community tree planting in England undertaken by the Woodland Trust, England's Community Forests, and more locally by local authorities, all look to establish the value of trees in urban areas. England's Community Forest network has been at the forefront of urban tree planting projects aiming to improve local aesthetics and address climatic changes associated with urban development (Gill *et al.*, 2007). Over the last twenty years they have allocated £125 million to create over 12,000 hectares of habitats and 10,000 hectares of new woodlands, (Blackman & Thackray, 2007); a level of green investment unprecedented in England.

Examples of this process include the Community Forests in North-West England who have established a legacy of green investments in the Manchester-Liverpool urban corridor counter-balancing the stagnation of the urban environment and decreases in green infrastructure (Community Forest North-West, 2011). The Red Rose Forest has led a program of neighborhood greening targeting the most socially deprived areas of Manchester. This work promotes community cohesion through environmental outreach work and community management of new green resources (Red Rose Forest, 2010). In a rural context East Cambridgeshire District Council (ECDC) has established the Planting Parishes project to increase woodland cover by 10% across the district. To date ECDC have achieved a 2-3% increase, a major achievement given the difficult political and financial position facing investments currently being felt by local authorities (Mell, 2011).

More recently North America has seen similar growth in community-led greening projects based around the regeneration of urban brownfields as small-scale agricultural plots. Areas of Manhattan and large tracts of central Detroit have been re-imagined as community gardens/farms, rather than as exclusionary spaces (Bull & Edwards, 2010). Schmelzkopf's (2002) work assessed the role of community gardening in New York's highlighting the social, ecological and financial benefits of such projects. She noted that community gardens provided spaces for local interaction, whilst also providing an affordable alternative to store bought groceries, thus promoting a greater level of social and financial parity. Schmelzkopf also

supported resident responses when the city attempted to sell these resources. However, $4 million was allocated to buy the land from Operation Green Thumb as the social and ecological benefits provided by community gardens for marginalized Latino and African-American communities were deemed greater than the financial value of development.

Although at a larger scale, Bull & Edwards' discussions of urban agriculture in Detroit suggests that green infrastructure can also work at a broader, though still local level. They argued that urban agriculture offer communities opportunities to invest and reinstate green infrastructure in areas of greatest need. They also suggested that a development fund budget ($30 million) could be allocated to such work (Bull & Edwards, 2010) to support projects including the Greening of Detroit, Earthworks Urban Farm and the Detroit Black Community Food Security Network. Each of these projects works with local communities developing long-term strategies for social development through localized landscape management. Steel articulated this process stating that planners need to stop viewing cities as large unproductive areas but see them as part of the productive organic framework (Steel, 2008), a notion heavily emphasized in Landscape and Urban Ecology.

GREEN INFRASTRUCTURE, BIODIVERSITY AND CONSERVATION

Whilst urban gardening provides one avenue for increasing urban greenery, protecting and enhancing biological diversity in urban areas, regardless of scale, is also a central benefit of urban greening. Whilst many authors including Natural England (2009) have examined the cumulative benefits green infrastructure can provide at a regional or state level, others including Qureshi *et al.* (2010) promote its ecological value at the local or city scale. Within urban areas derelict or brownfield sites therefore provide opportunities for biodiversity enhancement and conservation. The role of urban greening and gardening in New York (Schmelzkopf, 2002) is one example of urban space being re-interpreted as ecologically diverse. Furthermore, the second edition of the Cambridgeshire Green Infrastructure Strategy presents a number of key biodiversity enhancement targets around Cambridge, which aim to establish more diverse resources. This second strategy builds on the original and aims to continue to the development of biodiversity projects from the £21.9 million green infrastructure development fund (Cambridgeshire Horizons, 2011). Each of these projects promotes community involvement in urban biodiversity management by creating a sense of ownership of local resources. They also fostered a long-term engagement with the landscape that potentially supports future conservation.

Whilst research and project work in the UK has focused primarily on community engagement with biodiversity at a local scale, work in North America has taken a broader spatial approach. Given the focus on water management, biodiversity and conservation planning has been developed more frequently at the county or State scale (Benedict & McMahon, 2006). The Conservation Fund has been one of the most vocal agencies in this process working closely with county and state administrations to implement catchment or network scale biodiversity protection projects. Two of the most prominent examples of this practice have been the Seattle Open Space 2100 project and the Maryland Green Infrastructure Assessment (Weber *et al.*, 2006). Both programs identified water and biodiversity resource as principal priorities for protection. Therefore, whilst in Seattle the program looked to increase the density of Seattle's population it does so in order to allow Green Infrastructure to be

developed across the city (Rottle & Maryman, 2007). The management of people in line with what is deemed most appropriate for the ecology of the city is central to the Seattle plan. A further aspect of the plan is to integrate green alternatives to traditional transport engineering works by changing individual behaviors using innovative infrastructure planning.

GREEN INFRASTRUCTURE AND TRANSPORT

Our understanding that urban areas are over-populated with private cars is well versed (Beatley, 2000). However, there has been some reluctance, particularly in North America, to provide resources (funding or land) for alternative forms of non-motorized or public transport. Whilst growing numbers of people are cycling and walking the spatial configuration of many cities in North America makes it impractical to walk or cycle (Lindsey *et al.*, 2001). This differs drastically from the situation in mainland Europe where from the 1950's onwards there has been gradual growth in green transport options (Pucher & Beuhler, 2008).

Examples from Brazil (Curitiba), the UK (London) and Denmark (Copenhagen) however highlight that green infrastructure, or its principles, can be integrated with large-scale transport systems. Curitiba's public transport system was organized to provide hubs for buses, trains and bicycles at major intersections with public housing throughout the city. The city's planners identified that there was a need for infrastructure in residential areas, which could be linked through greenways to provide an integrated transport network for residents and commuters (Rabinovitch, 1992). London has promoted a similar approach to mass transit focusing on the connective nature of green infrastructure planning. The London bicycle hire scheme, (Barclays Cycle Hire Scheme or *'Boris Bikes'*) and the development of cycle super highway network have made cycling increasingly visible, popular and viable in London. Like Curitiba by linking residential areas across the city the cycle routes have acted as safe and accessible spine routes across London. Whilst these developments would historically have been seen as hard or '*grey'* engineering, because they focus of sustainable transport and health they support a green infrastructure interpretation (Taylor, 2008). The success of the cycle hire scheme also enabled the Mayor of London's office to leverage an additional £25 million of corporate financing to extend the project further.

Whilst Curitiba and London are examples of green infrastructure being used to promote sustainable transport other cities have been far more successful in adopting this process. In Belgium (Ghent), Denmark (Copenhagen) and The Netherlands (Utrecht) the promotion and adoption of a cycling culture suggests that a step change in behavior is possible at a regional and a national scale. (Beatley, 2000; O'Meara, 1998). Whilst such investment programs are not necessarily feasible in North America, Portland and Seattle are starting to utilize European interpretations of alternative transport to promote greener transport practices that can influence individual, but also work at a city scale.

GREEN INFRASTRUCTURE AND SPATIAL PLANNING

A number of examples exists of green infrastructure providing benefits at a city scale. Boston (USA), Copenhagen (Denmark) and London (UK) all rely heavily on the physical landscape to provide flood protection, alternative transport routes, ecologically important resources and

leisure facilities at this scale. Boston's use of Olmsted's Green Necklace provides flood mitigation, climate adaptation/stabilization and recreational resources across a large area of central Boston (Fábos, 2004). Green infrastructure investments at this scale may be rare given their perceived lack of economic value, however, Boston, Montreal and New York City have all prospered from Olmstead's visionary planning. Smaller scale projects than those in Boston and Montreal have also been developed in Stuttgart (Germany). Stuttgart utilize a range of green infrastructure to control the climate in light of its continuing expansion employing a 'wind paths' process to improve its air quality and the city's climate (Kazmierczak & Carter, 2010). Corridors of open space allow mountain air to move through the city delivering the benefits of cooling the air temperature of the city and improving air quality by disturbing static pollution. Building in these wind paths is prohibited and as a consequence over 60% of the city is planned functional green infrastructure (Masukazu, 2001).

Green infrastructure can therefore be designed to act efficiently at a city-scale, if developers and planners are made aware of the benefits that may accrue. However, they also need to be aware that the connective nature of ecological resources and the impacts of development on natural (air and water), social and economic systems. If a balance can be found between these issues then green infrastructure development can create high quality and environmentally stable cities (Mell, 2010b).

One way of achieving this is through the development of specific funding opportunities promoting green infrastructure development. The governments of The Netherlands and USA have established national level funding for green infrastructure (Beatley, 2000). Canada has developed the Green Infrastructure Fund linked to Economic Action Plans. The UK has created the Green Investment Bank to support economic growth and a move towards establishing a greener economy. Although each of these funds promotes a greener attitude to development and planning they are all linked directly to economic growth. This may prove problematic, as ecological viability and economic growth have been described as being somewhat incompatible (Tyrväinen, 2001). The role of resource management and conservation may also be marginalized in an attempt to achieve growth targets. Consequently, although successful examples of green infrastructure investment programs and funding mechanism suggests governments are beginning to attribute value to green infrastructure in urban environments the policy frameworks supporting them are potentially flawed in terms of delivery. As a consequence there has been a call to mandate policy addressing the value of green infrastructure and outlining a framework for its development (Mell, 2010b).

CONCLUSION: APPLYING GREEN INFRASTRUCTURE PLANNING IN FUTURE PLANNING POLICY

The application of a green infrastructure approach to landscape planning provides planners with a toolkit of options to aid the development of sustainable urban landscapes. The development of urban greening, biodiversity and transport projects can therefore all be supported through the application of green infrastructure principles. However, whilst practitioners have produced compelling evidence of its value there has been a disconnection between its use and articulation in green infrastructure policy. Consequently, green infrastructure is only mandated in a small number of national and regional level planning policies in the UK, Europe and North America, a position that is beginning to be addressed.

The value of green infrastructure, its use and mechanisms for funding have all been discussed at the national scale. However, as the case studies discussed above highlight, green infrastructure is being predominately implemented at a regional or city level. Subsequently, there has been an ongoing debate assessing the value of such policy in translating Green Infrastructure principles into practice. Examples from the North-West in England and Maryland in the USA support this proposal. Whilst policy provides the legislative framework used to assess the viability of green infrastructure development, its articulation in policy may actually dilute the effectiveness of its delivery. Given the nature of policy, i.e. PPS12 (DCLG, 2008) in the UK, to provide wide-ranging guidance it may not provide specific information to lead appropriate investments in green development.

An understanding of the implications of green infrastructure policy in relation to biodiversity, conservation or transport infrastructure is therefore still needed if appropriate development is to occur. The development of the second Cambridgeshire Green Infrastructure Strategy is one example where this process is being achieved (Cambridgeshire Horizons, 2011). Consequently it is possible to pose the questions that it may be more beneficial for legislators at the regional scale in to lead the production of policy and implementation strategies. The revoked Regional Spatial Strategies (RSSs) in England or state assessments (i.e. the Maryland DNR assessments) in the USA may offer the most effective catalyst to translate policy into implementation tackling climate change, transport and urban conservation.

Whilst discussions of policy continue to debate the utility of green infrastructure it is also prudent to assess examples of investments that have provided the maximum ecological and social benefits. The examples discussed previously highlight this process, however, other projects including $1.5 billion allocation by New York City to support the city's attainment of a greener and more permeable landscape focuses principally on improving water quality and storm water protection (NYC, 2010). Understanding the economic viability of green infrastructure is also important and reports from the Mersey Forest suggest that investments in green infrastructure can provide greater economic returns compared to investments in *grey* infrastructure. They state that for every £1 invested in greening projects £8 can be expected in returns (Mersey Forest, 2010). Furthermore, the City of Freiburg allocates £800,000 per annum for walking and cycling schemes, whilst there is evidence that Copenhagen supports cycling infrastructure with £9 million per year (Sustrans Scotland & Transform Scotland Trust, 2010). Thus, whilst the focus of green infrastructure may differ depending on location, funding and need, the examples discussed in this paper highlight its multi-functional value. The examples from Copenhagen and New York also highlight that directed investment in green infrastructure can be mandated in policy and delivered without the principles of green development being marginalized.

A green infrastructure approach to planning has provided planners with a far greater scope to review the interactions between people, the landscape and the resource base of a given urban area. There is also scope within this process to produce focused and adaptable policy in order to ensure that green infrastructure remains relevant in future discussions of urban development and sustainability. Thus, by thinking innovatively, and in some cases more holistically, about the form green infrastructure investment takes planners and developers can encourage greater social and spatial interaction with green investments, which in time will

promote a better understanding of ecological resources and decrease the competition between *grey* and *green* development.

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How to investigate and improve legibility of urban projects to make them understandable for blind people?

Contribution of Social and Behavioral Sciences Methods to Design for All Approach

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ABSTRACT

The following article is an overview of how well the architects are equipped with knowledge and rules of art regarding the issue of engaging disabled persons into user groups in environment built upon rules of full equivalency and a suggestion of further directions of complementing the Design for All principles and consequently rules and regulations based on research conclusions from related branches.

The research report analyzed legibility of urban space (and architectural), the way it was understood by Lynch (1960), as a dimension essential to ease of learning by blind persons of a given terrain and creating its cognitive maps. Four land management urban projects of Olympia Park Berlin (Pichselberg Tip) in form of tactile maps were presented to participants of research. After a standardized procedure of acquaintance with each of these projects a structured interview was conducted with each of the research participants, in which they were asked for items facilitating or hindering familiarizing with the map, learning the terrain and items potentially hampering individual movement around it. Qualitative data from these interviews as well as geographical data that presented trouble spots for blind persons in urban projects allowed determining which one from spatial systems was the most and which least legible and thus present recommendations for potential changes in eventual, further designing stages of Olympia Park Berlin.

Research presented in such format inscribes into participation design trend, which stipulates involvement of participants (future and/or potential) into designing process. Featured research, however, is an example of an urban projects evaluation method concerning the needs of blind persons and how can they become involved in designing process.

Keywords: Design for All, participatory design, cognitive maps, spatial orientation, blindness, tactile map

INTRODUCTION

Design for All is contemporarily a term functioning with certain connotation, understood rather as a symbol for opening environment to people with various disabilities, whereas these disabilities are perceived as existing within standards. This conviction was not easy to introduce – last decades of 20th century are an evidence of struggle in this area. They show a record of strenuous creation of designing standards for widened people's needs. (Kuryłowicz, Thuresson & Johni, 2005, pages 12-18). Drawing designing recommendations for such needs cannot be as simple as defining spatial parameters for example for passages accessible to wheel chairs. Acoustic and visual aspects of environment perception are more demanding issues, however for architects this is more an intuitive and experimental domain than normatively established conviction.

SPACE LEGIBILITY AND SPATIAL ORIENTATION OF BLIND PERSONS

Looking for designing solutions that will facilitate blind people's movements around a given terrain, learn it and understand cannot base on personal observations from designers' individual experiences. Differences between the blind and a person with blindfolded eyes result from different mechanisms of collecting and classifying spatial data about environment (Golledge & Stimpson, 1997).

From diagnose dimensions of architectural and urban space that decide on how easily blind persons can understand it and move around independently legibility seems to be the key factor. Repeated spatial elements, clearly visible rules of using it as well as topical continuation of different types of space facilitate coherence and legibility (Kaplan & Kaplan, 1982, after: Evans & McCoy, 1998; Lynch, 1960). Lack of coherence and legibility is also the cause of difficulties in creation of cognitive maps of a given space. Cognitive maps are spatial representation in users' minds (Downs & Stea, 1973; Gould & White, 1986). How detailed map-representation are we able to create depends on our individual ability of perception on one side, on the other hand depends on space characteristics, its legibility, cohesion, diversity or presence of distinctive points. Legibility of architectural space, its structure, is including: traffic routes, displacement of distinctive points makes it easier for users to move around it and find their way (Abu-Ghazzeh, 1996; Dogu & Erkip, 2000; Evans, 1980, after: Evans & McCoy, 1998; Gärling, Böök & Lindberg, 1986; Golledge, 1999a, Passini, 1996; Peponis, Zimring & Choi, 1990).

Tactile maps as representation of architectural and urban space

Use of maps is one of ways to purchase cognitive maps of terrain. According to McDonald and Pellegrino's (1993) classification the use of maps and other environmental descriptions is derivative space learning. For blind persons tactile maps are above all a tool to ease orientation in a given area (Arthur & Passini, 1992). Research proves that use of tactile maps of an unknown terrain simplifies moving around it. Use of maps raises efficiency and safety for moving by a given route in comparison to crossing it upon an earlier description or passing it with a sighted guide (Espinoza et all., 1998). Mode and technical parameters for preparing maps have significant influence on efficiency of their perception (Berla, 1982).

Guidelines regarding adequate marking of elements on tactile maps can be found among others in elaborations of American Printing House for the Blind (2004).

Depending on purpose of tactile maps to perform certain tasks and for certain needs of their users we distinguish different types of maps. According to James (1982) we can distinguish: (1) "orientation maps" that enable general perception of a given area, for instance the entire city or a block; they are drawn in a relatively small scale and contain most characteristic elements for a given area; (2) "mobility maps"; they are drawn in considerably larger scale so that all key elements can be clearly shown when moving across this given area.

Michel (2000, after: Harder & Michel, 2002) introduces a new type of tactile maps – "individual map" adapted to specified tasks and for defined users. A particular case of individual map being a conjunction of maps described by James (1982) is a target-route map. It contains a detailed representation of a chosen road and its surroundings in general outline with characteristic elements. Consideration of route's surroundings allows finding it once it was lost. It is important that on the target-route map the chosen route is considerably larger that its surroundings (Michel, 2000; after: Harder & Michel, 2002). Research on usefulness of target-route maps (Harder & Michel, 2002) shows that research participants get faster acquainted with target-route map than orientation or mobility maps referring to the same terrain.

Research target

Research described in this study inscribes into activities of participatory design that aim at verification of alternative design solutions and their accommodation to blind persons needs. Main target of the research was verification, which of urban projects prepared by students are easier to learn than others, thus are more legible, and why are they so perceived. It is anticipated that the complexity of spatial system of presented projects alters the ease of learning a given system upon a tactile map. It is assumed that blind persons will be able to indicate on tactile maps potentially difficult to them elements of area development from a spatial orientation point of view. Limitations arising from applied research data in form of tactile maps were taken into consideration in the analyses and drawn conclusions on legibility of suggested design solutions

METHOD

In order to accomplish research target and therefore answer questions quoted above a study in form of structured interviews with use of tactile data has been conducted. Qualitative data on declarative evaluation of development projects and usefulness of tactile maps as space presentation has been gathered. Subject to analysis were also mapping evaluation results on development projects as they present a graphic representation of evaluation of urban projects' legibility.

Participants

In research took part 12 blind persons (six men and six women) with age ranging from 32 to 74 years and all living in Warsaw, Poland. Most respondents are working (ten persons) and obtained a higher education (nine persons). All persons have declared a substantial loss of vision. More than half of research participants is blind from birth, three persons have lost sight in childhood (in second, third and seventh year of life). Two persons got blind – one since 15th year of life the other lost sight 2 years before the research. All respondents declared that they go out every day and use a blind stick when moving around. Five persons added that occasionally they use a guide. Only one person does not use city transit. All other persons use means of city transportations daily. All respondents read Braille and had earlier experience with tactile graphics.

Procedure

Each participant received all experimental maps (land development projects) and a control map. Entire experiment has been registered with a camera. Research participants, before they started their duties have been informed that there are no good or bad answers and that evaluated are not their abilities but presented projects. Respondents have not been informed that time of task fulfillment will be measured. Such information could disturb research results by raising participants' stress level or shifting their attention from map elements to task performance time.

Each time the interview consisted of two stages: preparation and research. During preparation stage participants were presented with a control map containing the elements consistent for all maps. These elements included: 1) area limits, 2) railroad tracks, 3) buildings that could not be moved by students in their projects, 4) main roads, 5) railroad platform. It should be noted that in one project roads have been designed underground and thus were not presented on the map. After acquaintance with the control map participants were asked to point out certain elements marked on maps. Apart from getting acquainted with location of elements common for all maps participants could at this stage get acquainted with texture of certain types of objects that were cohesive for all maps. Research phase included subsequent presentation of all maps of projects. Each participant was presented with maps in different order to avoid effects connected with order of presented data.

For each project map the research proceeded along the same scheme, which included: 1) phase of map learning, 2) phase of map analysis and 3) map evaluation phase. Learning phase included time to get acquainted with the map and to fulfill the tasks (indicate the platform and amphitheater) that verified the level of acquaintance and therefore readiness for next phase (analysis). During the analysis phase participants have been asked to find the easiest way from the platform to amphitheater and then show this way and describe the route. During the last phase of interview the spatial data regarding evaluation of development projects was gathered. Evaluation rested on indication by respondents the illegible places, difficult and too complex to imagine and how potentially they could pass them. During this part participants have been also asked for a declarative evaluation of the complexity level of the spatial system, and ease in learning the map. Upon presentation of all project maps came the phase of summation of results. Participants have been asked to point out the easiest and the most

difficult map. They were asked about the usefulness of tactile maps as a tool helping to learn a given terrain. They were also asked to express their opinion and observations regarding technical side of using tactile maps.

Research material

For the purpose of the experiment all projects we used in experiment were assigned with capital letters: A, B, C and D. Specific character of tactile maps and the way they are being used imposed in research material the consideration for only significant elements. Apart from the area limits and the railroad track only buildings and roads have been marked. Also tactile maps contained no information about terrain topography. In addition the adaptation of projects to tactile function meant perturbation (in relation to original values adapted in projects) of spatial relations between objects. Certain objects (buildings and roads) were enlarged/reduced, pushed away from each other and deprived from details so that they could be easier read with fingers. Maps were prepared using Braille print technique on "Tiger" ViewPlus printer. According to classification of tactile maps (James, 1982) the maps used in this research could be described as mobility maps.

RESULT

Spatial and declarative evaluation of legibility of development plans

Upon familiarization with all development projects and completion of all tasks participants have been asked to evaluate which map seemed to be the easiest/most difficult from their point of view. This question has been accompanied by auxiliary questions such as: on which map it was easiest/most difficult to find a good way, which was easy/difficult to learn, which one of spatial systems was easiest/most difficult to move around. Figure 1 shows easy/difficult classification of the maps.

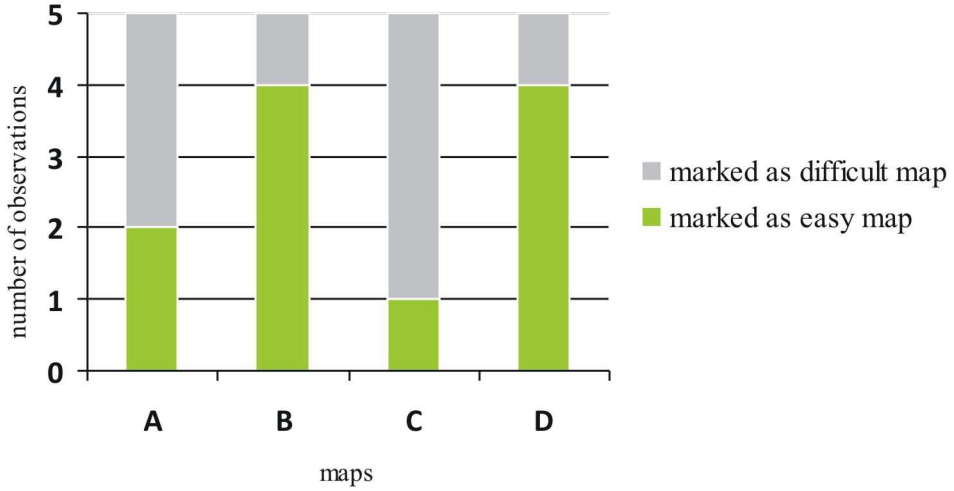

Figure 1: *Evaluation of development plans as the easiest or most difficult.*

Figures 2-5 present the spatial evaluation of subsequently projects A, B, C, D. Development project's maps contain information on which routes were indicated by respondents and which of them they have preferred. In addition we have marked places considered by respondents as complex and difficult to pass – illegible as described in bibliography. It has to be noted that for the respondents term "legible" had two default meanings: legible preparation of the map (map easy to read – technical aspects of preparation) and legible spatial system (simple, easy to imagine). In most cases research participants understood "legibility" in its first meaning, what is significant from the relevance of questions' point of view. In description of results the term "legibility" shall be used as understood in bibliography.

In projects A, B and D research participants most frequently negatively marked the road intersections. The issue of intersections was particularly a problem in projects A and B. Respondents have marked that there are a lot of intersection and road forks. Moreover, when examining the maps and seeking the way they were disturbed when intersections had more than four leaving roads and when the roads did not cross at a straight angle. Following quotations give a good idea what kind of problems are being caused by such intersections:

> "*… If this was prepared with consideration for the blind and generally disabled people, then the simpler footpaths or communication routes are the better. Communication routes should intersect at straight angles. One should avoid V shaped forks or open angles; as such intersections are poorly legible for the blind. There must be an absolutely straight angle. Moreover footpaths should not be wavy or curved left or right like a zigzag, they should lead straight ahead. I speak not only for the blind but also persons on wheelchairs for which it is also easier to drive straight than maneuver."*

> "*Such slant (project D; point of junction of two roads running from the platform) should be avoided, because if I leave from here (from the platform) then I can leave, but if I go there (from amphitheater) then just straight up, if I happen to meditate I could touch with my stick the edge of a wrong path. I won't be able to feel that I am moving slightly right when I wanted to go left."*

In addition untypical road intersections on examined maps have caused that respondents declared problems in finding continuation of their way, even when they repeated showing the road that was already found.

In project A participants noted that roads are "*very meandrous*". On the other hand the information points proved to be helpful in road finding and acquaintance with the map, although many respondents noted that "*there are an awful lot of them*".

Participants examining project B and performing tasks on this map often noted the large number of roads, an "*entanglement*". However, this plan was marked as the simplest of all and a statement was made that "*straight angles generally have been preserved*". Respondents recognized diversification of road width as an additional help in reading this map, since it allowed distinguishing main roads from secondary.

From opinions registered during phase of acquaintance with maps project B comes out as easier when preceded by project A, and as more difficult, however, when preceded by project D.

Evaluations of project D were dominated by remarks about smaller number of roads. However, it has been considered doubtful that these roads failed to intersect at straight angle. There were also negative remarks questioning roads that *"have no obvious purpose"* (loop in upper part).

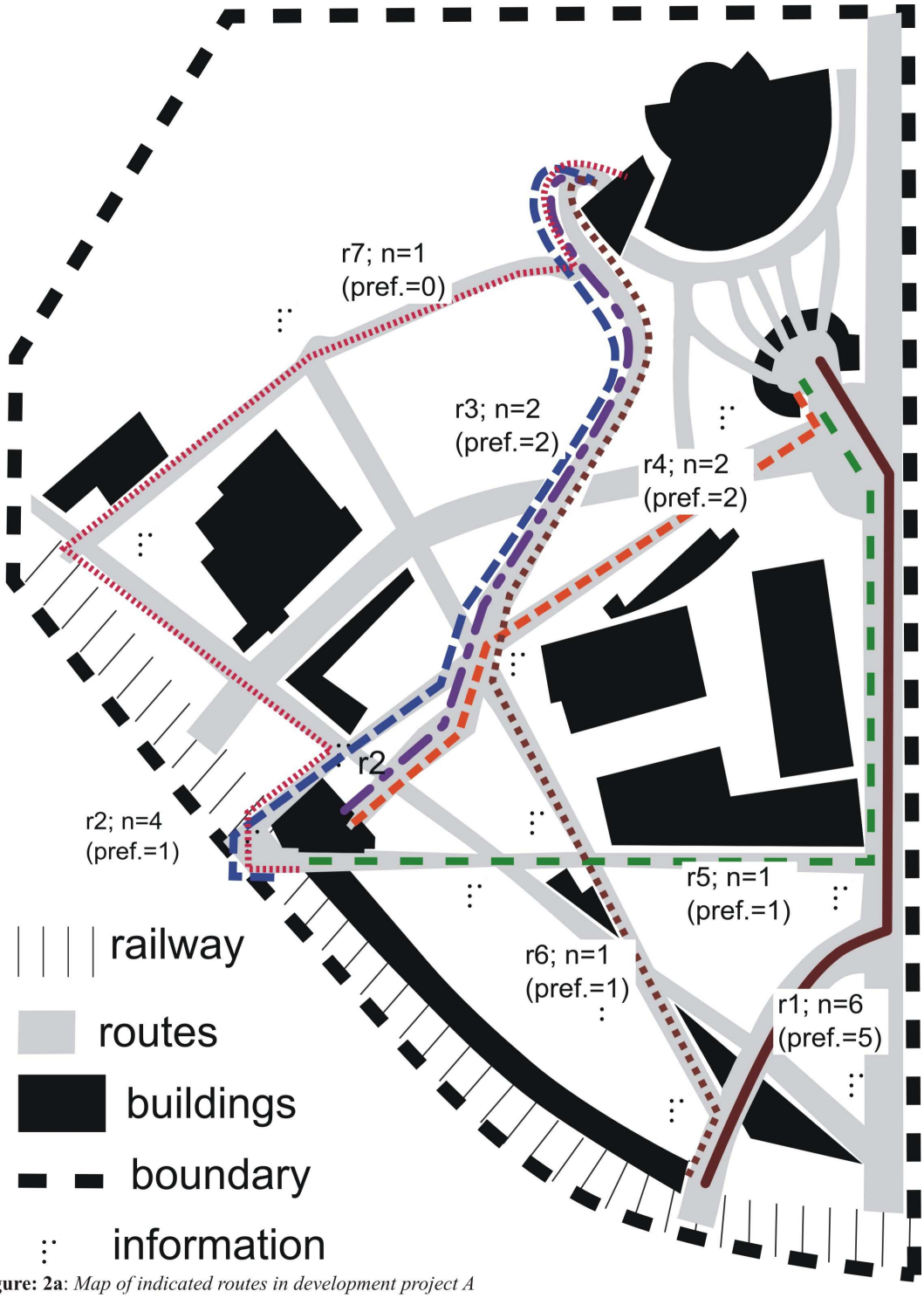

Figure: 2a: *Map of indicated routes in development project A*
(r1, r2, ... - marking of routes; pref. - route indicated as preferred)

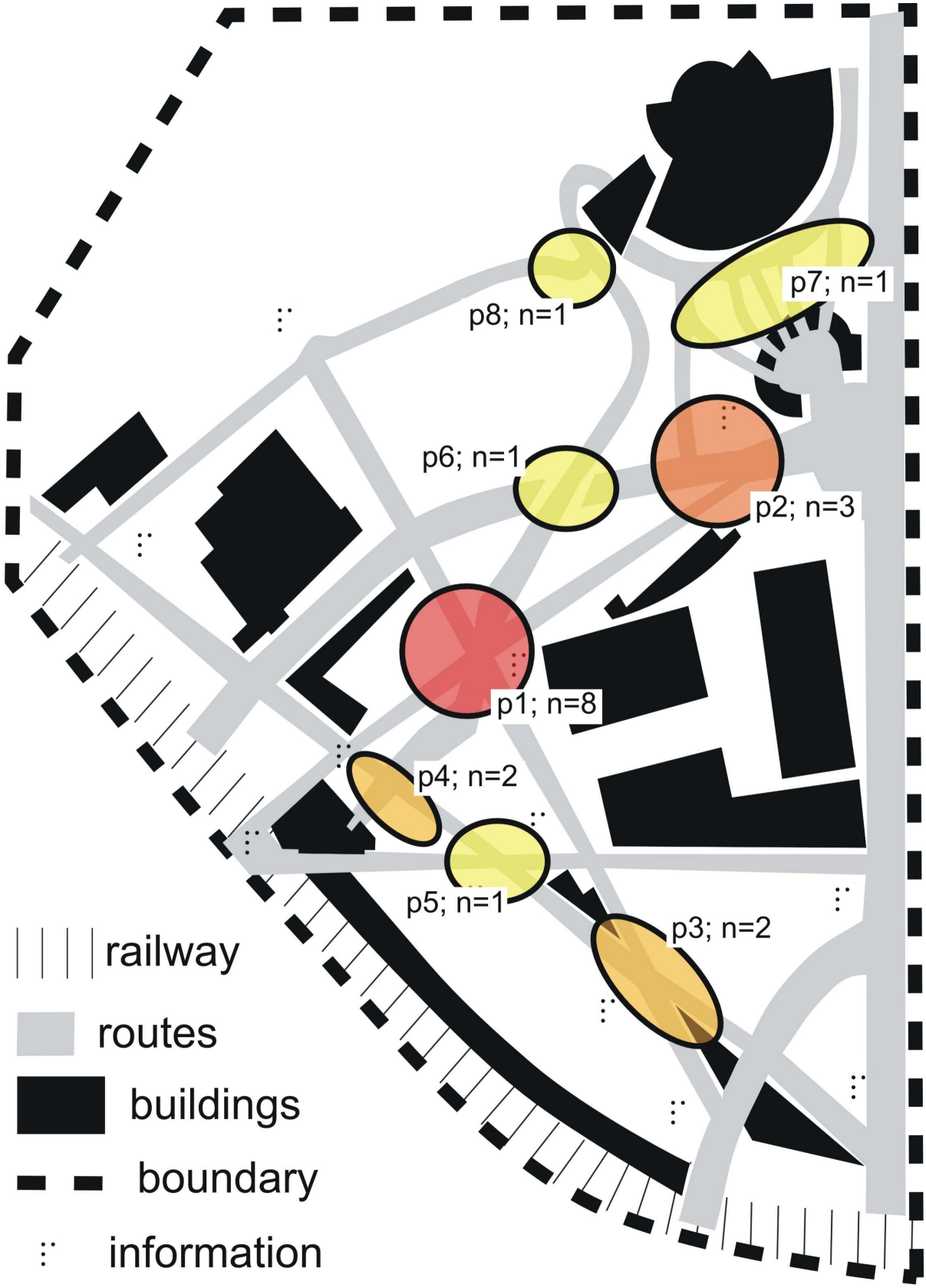

Figure: 2b: *Map of illegible places in project A (p1, p2, ... -marking of places).*

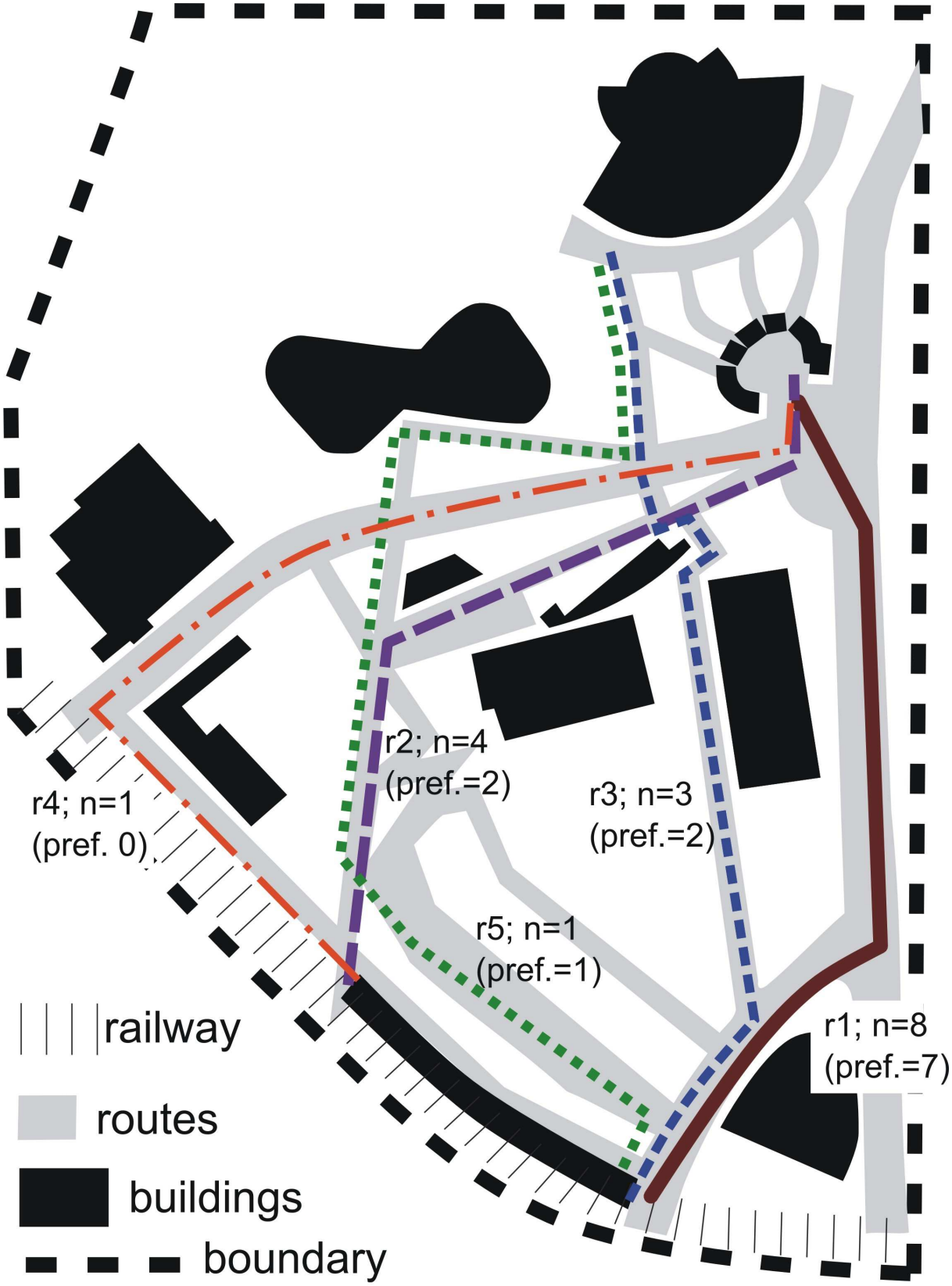

Figure: 3a: *Map of indicated routes in development project B*
(r1, r2, ... - marking of routes; pref. - route indicated as preferred).

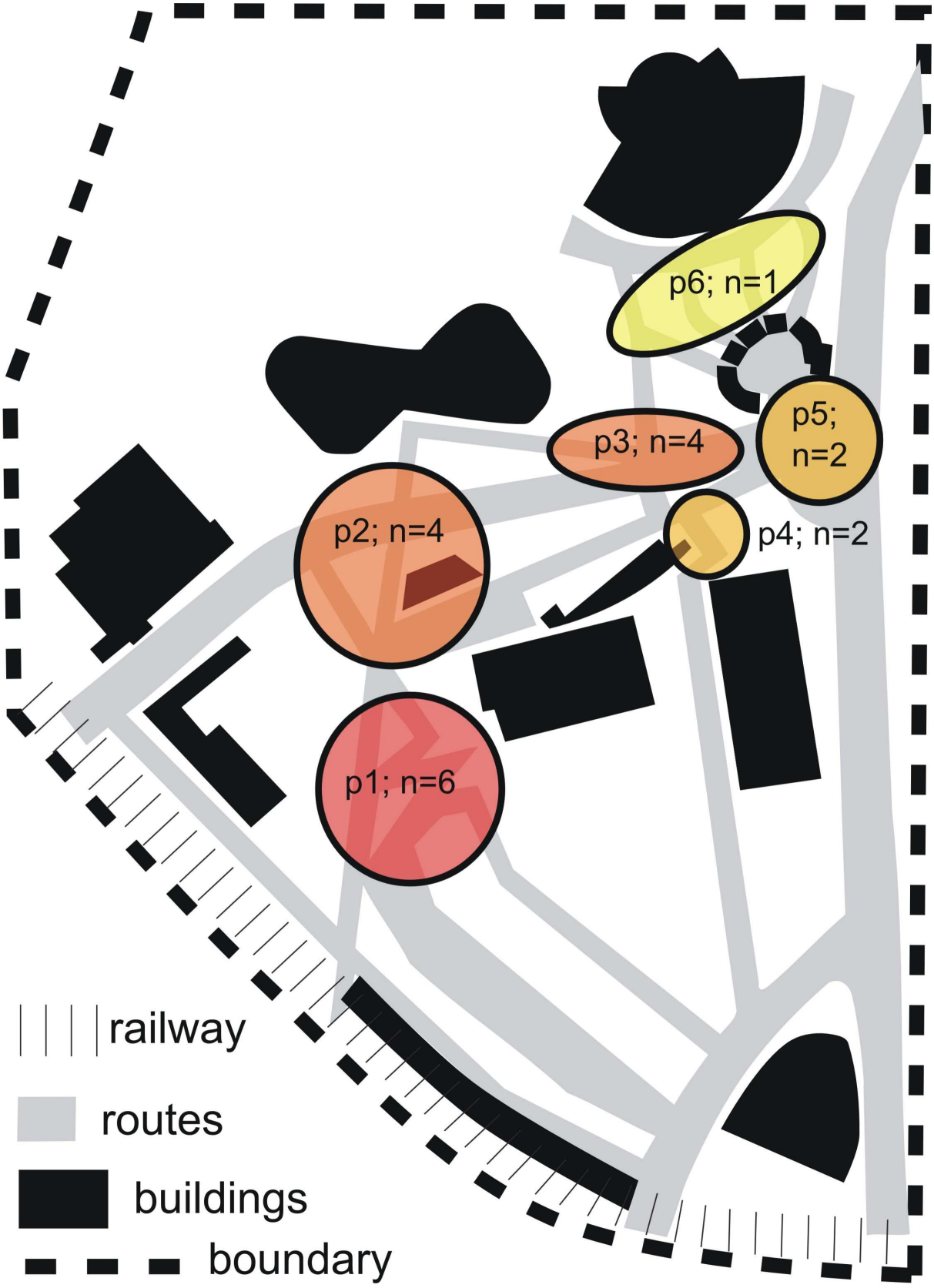

Figure: 3b: *Map of illegible places in project B (p1, p2, ... -marking of places).*

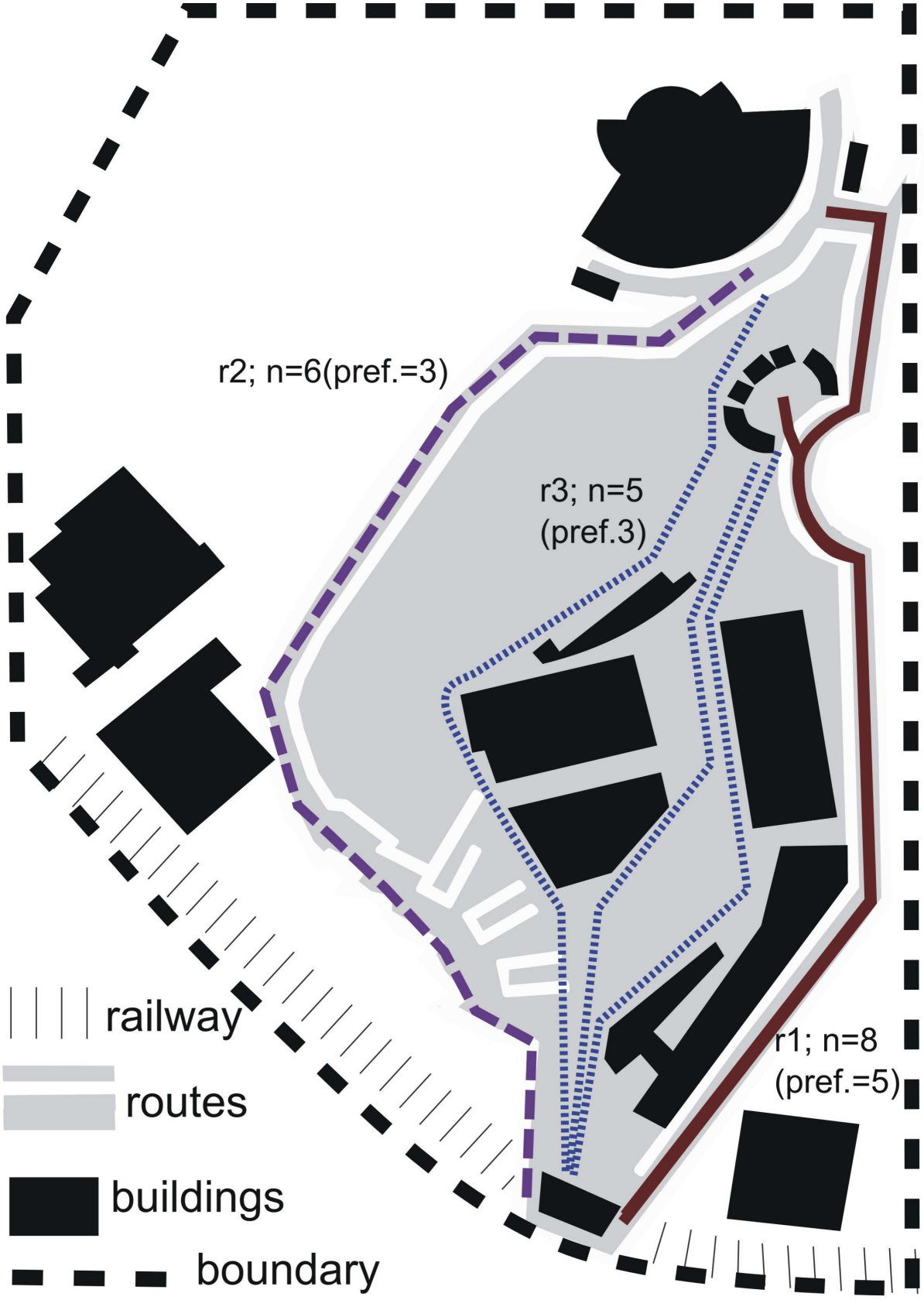

Figure: 4a: *Map of indicated routes in development project C*
(r1, r2, ... - marking of routes; pref. - route indicated as preferred).

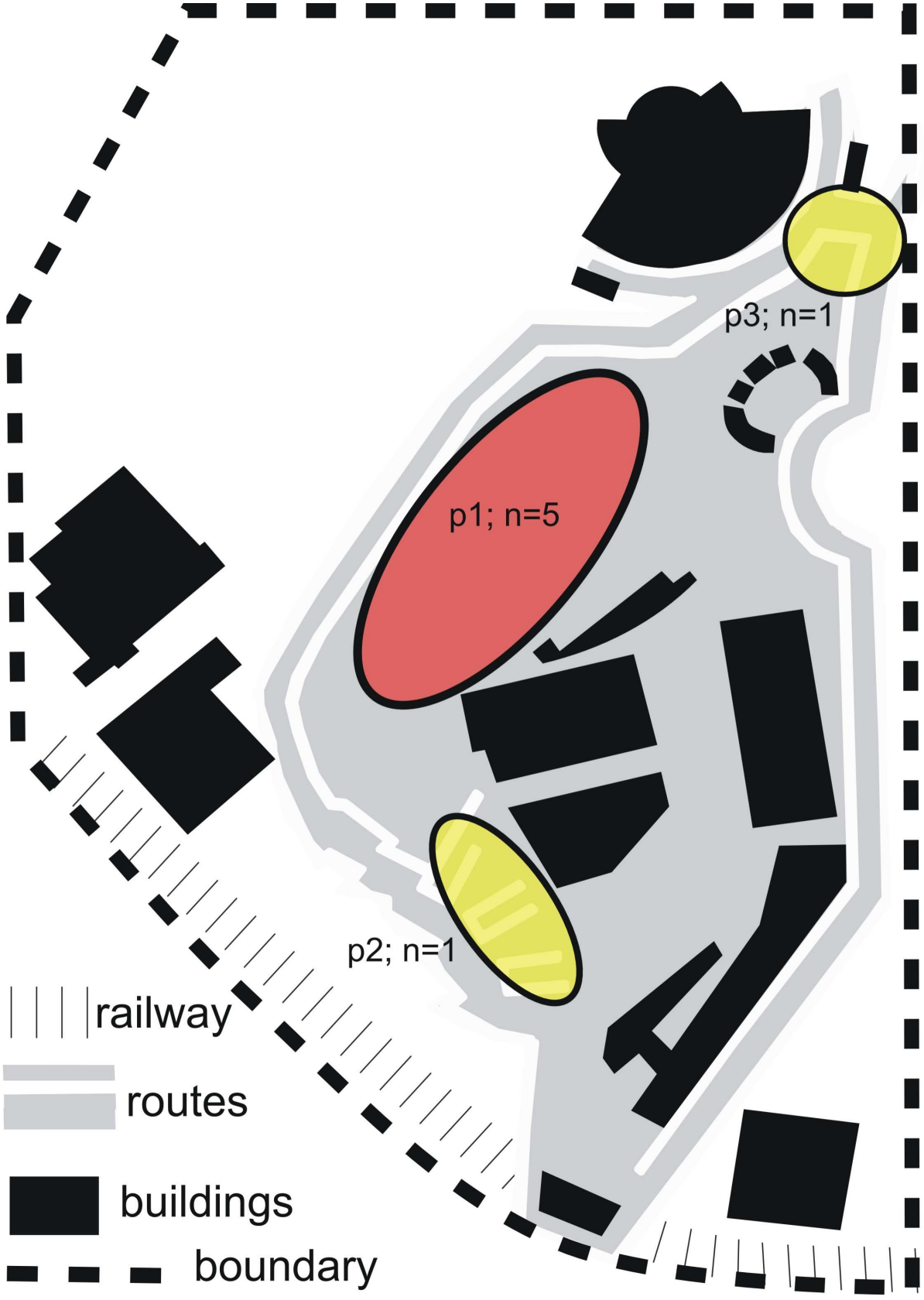

Figure: 4b: *Map of illegible places in project C (p1, p2, ... -marking of places).*

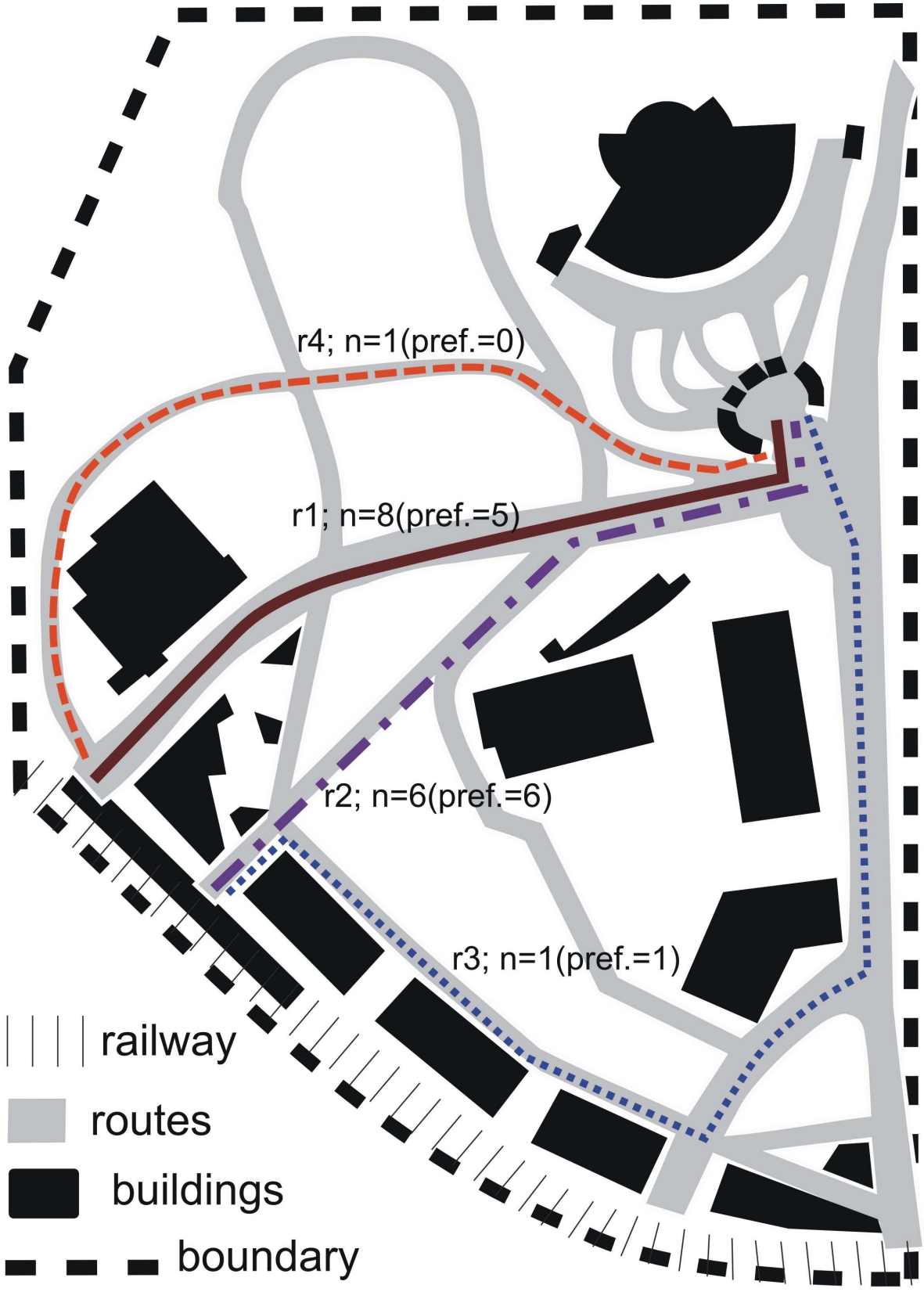

Figure: 5a: *Map of indicated routes in development project D (r1, r2, ... - marking of routes; pref. - route indicated as preferred).*

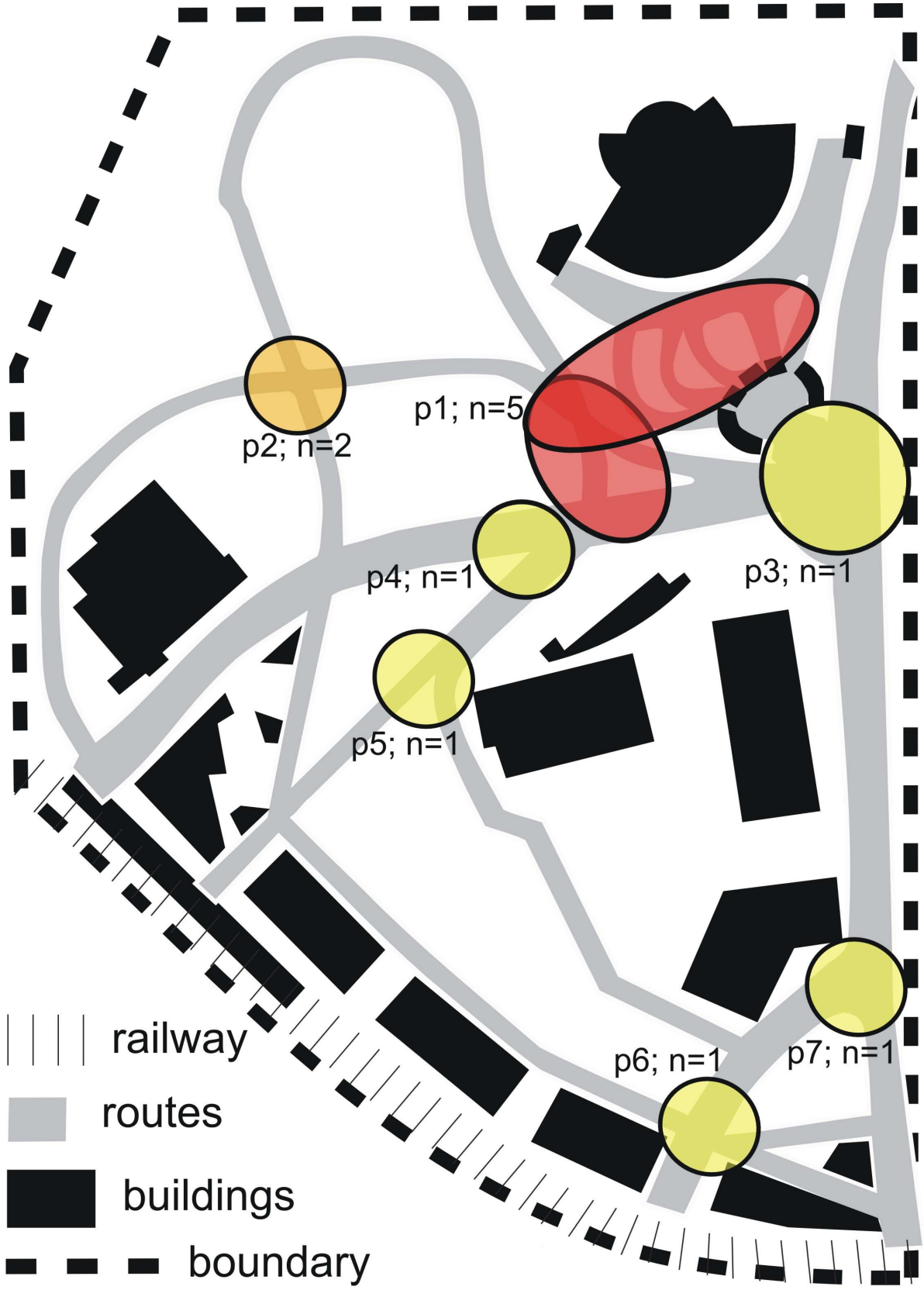

Figure: 5b: *Map of illegible places in project D (p1, p2, ... -marking of places).*

Project C in comparison to other projects differs by the way the area has been managed. Instead of numerous exactly predefined roads there is an open space – squares, which can be walked and two routes leading from platform to amphitheater on borders of designed area. The differences in reception of project C and other projects could be well described by this quotation:

> *"This map is less complicated than other. There are fewer elements. There are no predefined routes; it is me who had defined the route. There is actually an open square. I do not like such situations, this does not mean that it is wrong, but it is wrong for me."*

Negative reactions to open spaces, plots, prevailed in evaluation of this project.

> *"I must say it straight on that it is an awful terrain. Because I have a feeling that this whole area is asphalted and for me that means this is a square and I would definitely get lost."*

> *"A blind person does not like open spaces. In an open space, though there would just be the road, particularly with left or, right forks one can get lost. All you have to do is to get a little abstracted in your mind and you could wander off right instead of going straight, particularly when such forks exist."*

The generally negative evaluation of entire project C could be the consequence of how open space was perceived:

> *"One had to adjust somehow, this map was more difficult in feel, but these roads were OK, I liked them."*

> *"The most difficult was the one that had those funny sidewalks, although the roads were easy."*

The route running by eastern border (see Figure 4a, route r1) has been more frequently indicated as preferred. The following quotation pretty well shows its advantages:

> *"The best is the one on the right side, because I have there two good landmarks. Here, I go between the buildings and the building on my left side indicates the direction to me. I have here two buildings that actually lead me through more than half of the way. For me it is important that I can walk along the buildings."*

This road, however, has been also rated as too winding near the amphitheater.

> *"…only this way, since this is such a nice designated road and leads nicely right up to ticket office. It winds however, has many curves, but should one know that this is the road to stick to and follow it as it goes then it is fantastic."*

DISCUSSION AND GENERAL CONCLUSION

The research gathered and analyzed qualitative data, including declarative evaluation of projects' legibility. The results allowed verifying urban projects. Most frequently respondents have rated maps B and D as the easiest in general perception of their legibility. Simplicity of map D could result from, declared by the respondents' impression, of the smaller number of elements (roads and intersections) as opposed to other projects. In addition the review of declarative ratings shows that respondents recognized map B as more difficult when it was presented after D and simpler when presented after map A. On this basis we can assume that map D was the easiest (most legible), followed by B, A leaving map C as the most difficult in view of the respondents. Maps of indicated preferred roads (see figures: 4a and 5a) show that in case of both projects routes d1 and d2 have been picked with similar frequency. Thus it can be assumed that these two routes were equivalent alternatives to some extent.

Project A can be considered as the most complicated when considering the number of places marked as difficult (Fig. 2b) and the number of alternative roads (Fig 2a) that have been indicated by the respondents. Finally, however, during declarative evaluation of maps' difficulty level project C has been most frequently declared as the most difficult. Rating of project C as the most difficult resulted mainly from blind person's impression about contact with open space. Open space is difficult from practical point of view; it causes confusion that can lead to stress and anxiety (Zimring, 1984). Research participants shared this reflection. Open space proved to be doubtful also during the acquaintance with the map stage (see Figure 4b), and creation of mental image of presented terrain. Taking into account declarative evaluations it can be assumed that rating of map C as the most difficult stemmed from impressions and imaginations of respondents regarding the open space. Significant level of area development complexity in project A has obstructed fulfillment of tasks, however this project was not perceived as negatively as open spaces on plan C.

Collective results of routes indicated by respondents as preferred show that in projects with existing roads preserved on surface in Pichselberg Tip area the most preferred route (d1) led along the already existing roads, geometry of which could not be altered by the students (see Figures 2a, 3a and 5a). This regularity urges a reflection, particularly when we assume that an urban project should bring new/better values to existing land development.

To places identified as most difficult – the least legible are all intersections with more than two roads and intersections that cross at an angle other than straight. As known from the literature of the subject (e.g. Dąbrowski, 1964) and from declarations of research participants the easiest way for a blind person to orientate in space is when they can make a 90 degree turns. Straight angle is for them the simplest way to identify and to learn. Moving on a curve or taking open or sharp angle turns may cause loss of orientation or disturbances with regard to elements of space and cardinal directions.

Application of qualitative research methods which combined structured in-depth individual interviews with spatial analysis of data have resulted in precise diagnosis of the analyzed area development plans. Data from interviews and map results allowed for a detailed verification of crucial points in certain project solutions. The research presented in this study can serve as an efficient tool for evaluation of an urban project from the angle of spatial system's legibility

for the blind people. The best moment to introduce such analysis in designing process is at a relatively early stage of an area development general concept's creation.

This research may serve as an introduction to further analyses – the quantitative research. For example research executed in an experimental framework, using time measurements by fulfillment of tasks on research material could clarify possible significant differences between presented projects, which could influence their specific rating during the interview.

As this research shows a shape of built environment cannot be only the result of activities of architects and urban planners, although they are the only ones from the team of other experts that participate in shaping of the world, whose knowledge concerns an individual, are educated to holistic activities, collecting and synchronizing other peoples' knowledge in order to improve the existing environment and that suggested for improvement.

ACKNOWLEDGEMENTS

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Stormwater management: Designing urban hydrological systems as infrascapes

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ABSTRACT

Water infrastructure tends to be designed as networked systems. Such systems can be found in nature as well, for example in the self-organizing systems of mycelia fungi. Understanding their mechanism leads to a design approach that interweaves urban water infrastructure with open space planning. Core principles learned from the fungi were applied to a site in New Orleans. The design strategy concentrated on improving the quality of the open space as well as linking storm water management with engineering and urban design strategies. Flexible and resilient solutions that blend centralized as well as de-centralized water infrastructure with the urban landscape became the basic planning strategy. Small scale solutions were designed for specific situations and connected with larger scale systems, both as technical infrastructure and as integral parts of an open space framework, reframing the urban landscape as a continuous infrascape.

Keywords: Storm water, landscape infrastructure, networked systems, ecological engineering, resilience, infrascapes, water sensitive urban design, New Orleans

WHY INFRASTRUCTURE MATTERS

Technological networks are mediators through which the “perpetual processes of transformation of Nature into City takes place” (Kaika & Swyngedouw, 2000). Much of the material and technological fabric of cities, then, is networked infrastructure. At the same time, much of the infrastructural fabric is urban 'landscape' of various sorts. Almost every aspect of the functioning of infrastructure, the retrofitting of new networks and the renewal of older networks is focused on the needs of serving (and) expanding urban areas (Graham & Marvin, 2001). According to the latest United Nations population projections, 4.9 billion or almost 60% of the world population are expected to be urban dwellers in 2030 (United Nations Department of Economic and Social Affairs/Population Division, 2006). Consequently

Infrastructure as the key physical and technological constitutive of the urban process has recently come much more into focus (Allen,1999; LeCavalier, 2010; Hung, 2011).

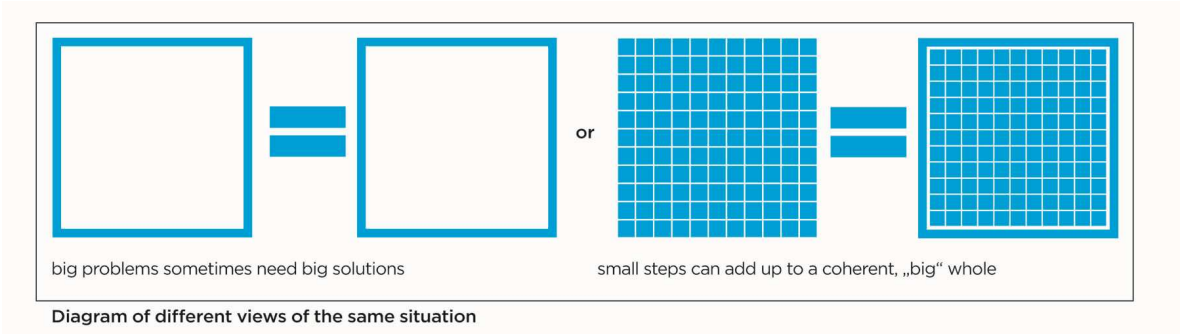

Figure 1: Different angles of the same situation

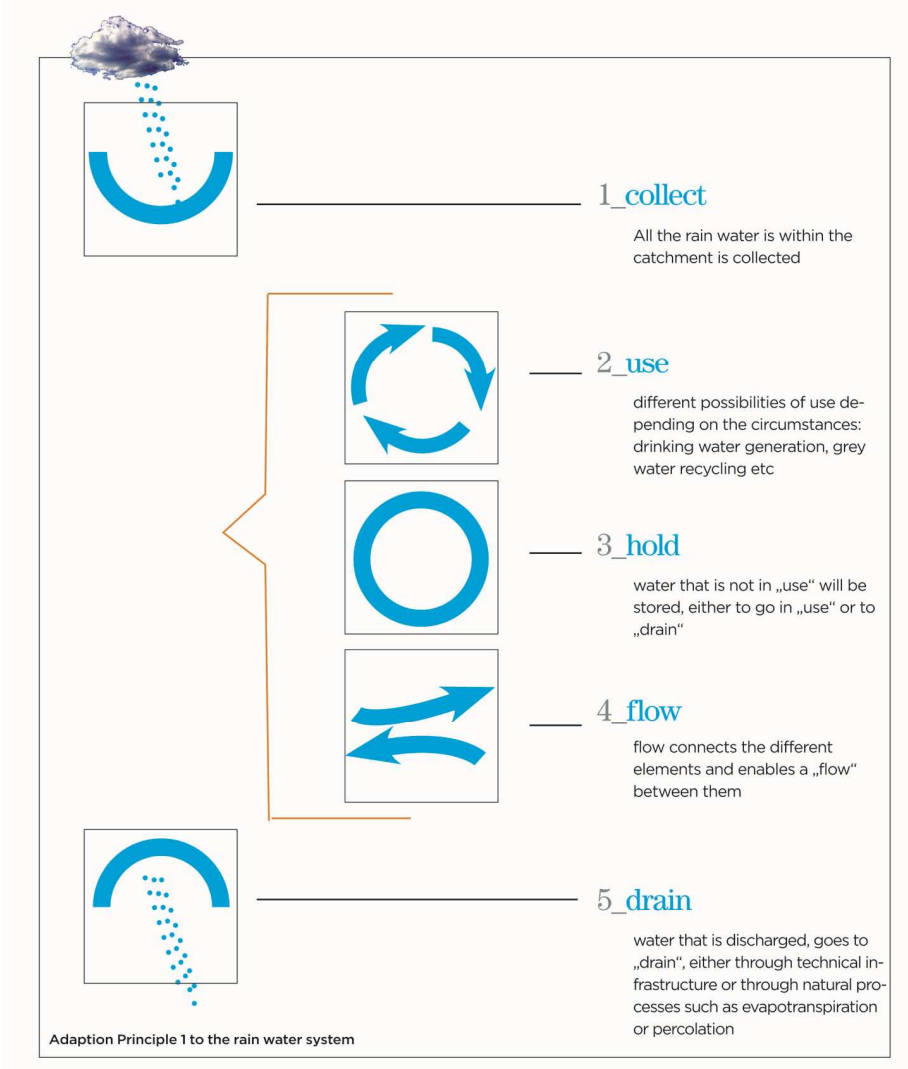

Figure 2: Five typologies to describe a spatial approach to storm water management

WATER MANAGEMENT HAS ALWAYS PLAYED A KEY ROLE IN THE URBANISATION PROCESS

The management of the water system has been a predominant task in the urbanization process: claiming the ground for the city as in the Netherlands (Palmboom, 2010), protecting the city from floods, supplying fresh water to its inhabitants or removing water after use (Whiston Spirn, 1984; Swynegedouw, 2004; De Meulder & Shannon, 2008).

Recent climate changes have made the handling of storm water an urgent issue that cities need to address. In the past 150 years the approach to urban water management has been to collect storm water with a system of underground pipes and channels and to disperse it as fast as possible (Garver, 1998). This technology is now being viewed critically. Drainage of storm water from surfaces reduces groundwater infiltration and lowers groundwater recharge rates. Instead of seeing water as a threat cities will need to regard it as precious resource in the future (Kluge & Scheele, 2008). Approaching storm water management as a decentralized system is a chance to create multifunctional urban spaces to help cities in the paradigm shift towards sustainability and enhance the open space quality for its inhabitants (Stokman, 2008; Hoyer, Dickhaut, Kronawitter, 2011).

THE INTELLIGENCE OF NETWORKED SYSTEMS – LEARNING FROM MUSHROOMS

Water infrastructure tends to be designed as networked systems. Such systems can be found in nature as well, for example in the self-organizing systems of mycelia fungi. Fungi form some of the largest and oldest living organism on Earth and they have been of special interest to the study of networked systems. Studies by Dr. Mark Fricker at the Department of Plant Science, Oxford and his team have shown, that they grow as self-organized networks, explore new territory to search for resources, maintain an effective internal transport system and can adapt during development by selective reinforcement of major transport routes and recycling of the intervening redundant material to support further extension. (Fricker et. al., 2008)
In this they apply the same strategies that can be studied in complex systems: growth and decay, self-organization, repetition or iteration of localized actions. Their bottom-up strategies as well as the absence of equilibrium are ideally suited to a process-oriented design process, that learns from an understanding of dynamic systems in which form relates to movements and change (McHarg, 1969; Forman, 1995)

Learning from mushrooms: 5 core principles

Five core principles were learned from the self-organizing networks of mycelia fungi and cellular slime molds:

Principle I_thicken the surface
Just as the mycorrizha formed between plant and fungus enlarges the surface area, adding additional function to the surface is beneficial. Avoid mono-functional structures, add function to the surface where ever possible and create an abundance of microsites
Principle II_interweave microsites

Look at structures and surfaces as microsites that can be woven together, the whole is more than a sum of its parts, all structures are interconnected

Principle III_connect different systems
Keep old systems, but add new systems: depending on the scale of the site they can be small or large, innovative or if a high safety level is needed more conventional and tested

Principle IV_allow for growth & shrinkage
Create reversible facilities that can be dismantled and transformed according to the situation, allow for unprogrammed space to accommodate new activities that are unforeseen

Principle V_look for network robustness
Design systems with inherent resilience by taking advantage of fundamental properties such as diversity, efficiency, adaptability, and cohesion.

TYPOLOGIES TO DESCRIBE THE WATER SYSTEM

Five typologies are used to translate the strategies of the self-organizing networks of fungis into a spatial approach to storm water management. They enable the planer to precisely describe the water system.

1_collect
All the rainwater within the catchment is collected.

2_use
Different possibilities of use depending on the circumstances: drinking water generation, use as grey water etc.

3_hold
Water that is not in *use* will be stored, either to go in *use* or to *drain*.

4**_flow**
Flow connects the different typologies and enables a *flow* between them.

5_drain
Water that is discharged, goes to *drain*, either through technical infrastructure or through natural processes such as evapotranspiration or percolation.

The three new types of *hold, use,* and *flow* will connect the water system and its technological solutions with the urban landscape. As a result a water system is installed which enables rainfall to soak away–or to be retained–in the area where it falls, as well as delaying its delivery to the receiving waters, thus imitating natural geological systems.

The *hold* typology looks for decentralized water retention areas. As much rainwater as possible will be retained on private and public ground and be allowed to soak away, and only

limited amounts will be drained off. This will be achieved by using the functional elements of retention areas, gulley-and-trench systems, rainwater reservoirs and porous surfaces. Besides built elements an increase of planted surfaces is aimed for.

Hold offers a variety of possibilities in creating attractive spaces out of currently "unprogrammed" leftovers, the "urban voids". American infrastructure adds the special feature of "neutral grounds" – large green spaces between the two lanes of roads that can be used as "rain gardens". *Hold* elements include green and "blue" roofs as well.

In *use* new technologies such as the "HydroSkin" are introduced. These work mainly on *solids*, the structural elements of cities, housing blocks, etc.

Flow means the possibility of moving water within the city, which can be a relatively low energy event within a city depending on its topography and technical infrastructure.

Elements within the system are connected with each other and can form stronger links or reduce the strength of the connection. This allows the system to adapt to changing conditions such as shrinkage or growth, or changing levels of protection. Water will be contained within the system as long as possible, either in *hold* (above ground/below ground storage, open retention areas) or in *use* (recycled with smaller sub-systems).

Keeping the old, towards a fast *flow*-oriented infrastructure system intact, while simultaneously changing and adding the new elements of *hold* and *use* on various scales, enables a renewal of the water infrastructure as a more flexible and resilient system.

Just like fungal networks are not just part of an organism–they are the organism–all surfaces of the urban form are infrastructure and contribute functionally as well as aesthetically.

FIELD TESTING THE CONCEPT: LAFITTE CORRIDOR

These core principles are "field tested" on the Lafitte Corridor in New Orleans, a largely abandoned rail corridor that connects the historic French Quarter with Mid Town.

New Orleans has been in the news mainly with pictures of destruction by hurricanes such as "Katrina" in 2005. But even on a day-to-day basis the city has to deal with enormous amounts of water. It has a high rate of precipitation, almost twice the yearly amount of cities in northern Germany, and is located on former swamp- and marshland that has only been settled after draining the soil. Seepage from the Mississippi River and Lake Pontchartrain has to be constantly pumped out of the city and the high water table (in certain areas just 40 cm below the ground) makes percolation of rainwater into the ground difficult (Meyer, Waggonner & Morris, 2009).

Lafitte Corridor is a 3.1-mile largely derelict strip of land along a former shipping canal and railway that once connected the historic French Quarter to Bayou St. John, owned by the City of New Orleans. A previously important connection that had been largely forgotten for years and has now come back into focus as a possible pedestrian green finger connecting the French Quarter at the Mississippi River bank via Bajou St. John with the shore of Lake Pontchartrain.

The urban plan focused on four criteria:

I_Increase Density

The neighborhood adjoining Lafitte Corridor is suited to increase density in the area. It is close to the French Quarter and a large site in New Orleans. This should be considered in the planning process replacing the demolished Lafitte Housing Complex. Buildings of two or three floors and flexible floor plans that adapt to the many single households as well as to families with children will attract mixed income communities.

II_Improve Connectivity

There is currently no green spatial connection between the French Quarter and Lake Pontchartrain via Bajou St. John. Using Lafitte Corridor as the link between the French Quarter and Bajou St. John will connect these two attractive spaces and will draw tourists to explore areas beyond the French Quarter. Along Lafitte Corridor a variety of small business catering for the people living in the quarter as well as for tourists can add attraction and income to residents. The green space will stitch areas back together that were divided by the canal and will rejoin streets that are currently cut off.

III_Restore Green Finger

Lafitte Corridor offers a unique opportunity to create a green space between Mississippi River and Lake Pontchartrain. The green finger enables walking or bike cycling from the Mississippi River up to Lake Pontchartrain. Areas within the Green Finger can become productive with orchards and urban farming. Green finger extends to green roofs vertically.

IV_Water Management: Hold, Re-use and Drain

Instead of a new large structure such as a canal or a new pumping station to control excess storm water in the area, a strategy of small and adaptive measures is chosen. New large structures are in a way a further development of “path-dependencies” resulting from infrastructure developments in the late 19th century.

The design approach uses existing structures and land forms to weave water retention into the urban landscape. A number of small water systems is linked together and connected to the current water drainage system. The current system is the “safety net”, new innovative water strategies can be tested within the system.

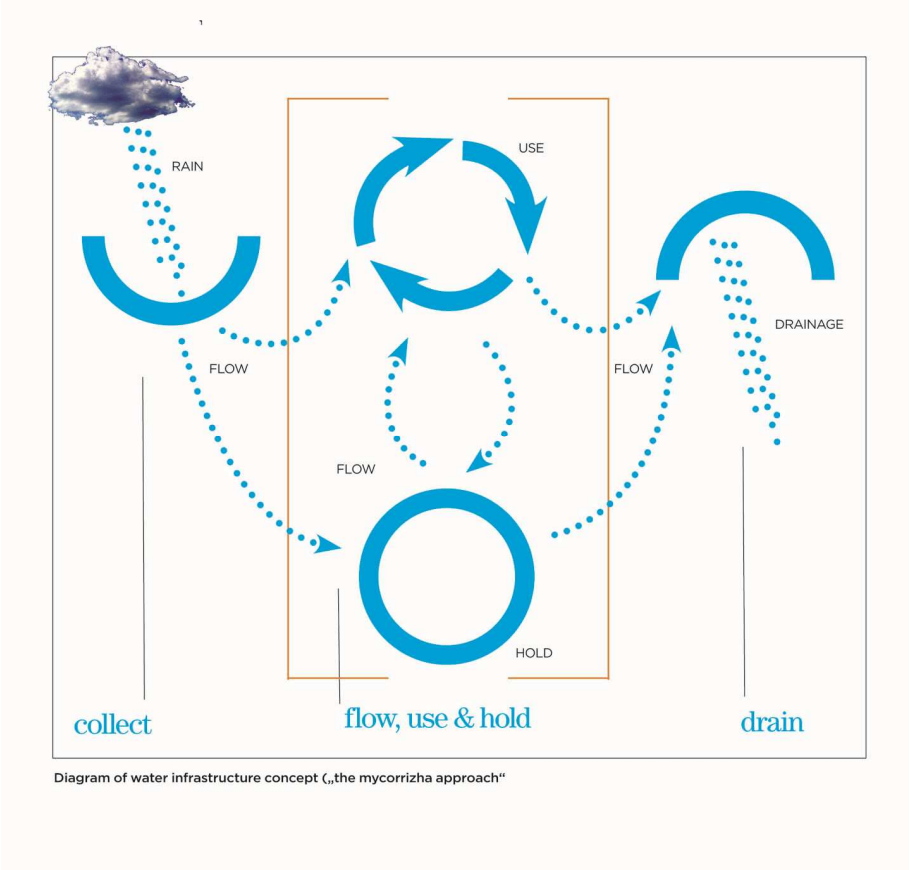

Figure 3: Diagram of a biologically inspired networked water infrastructure concept ("the mycorrizha approach").

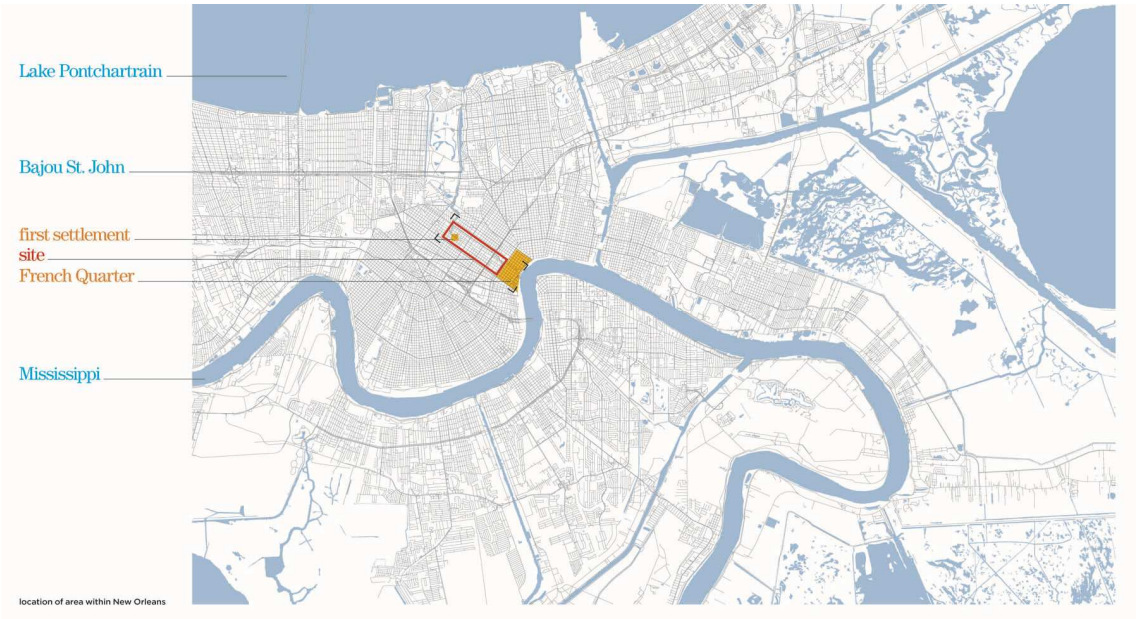

Figure 4: Site location within the area of New Orleans

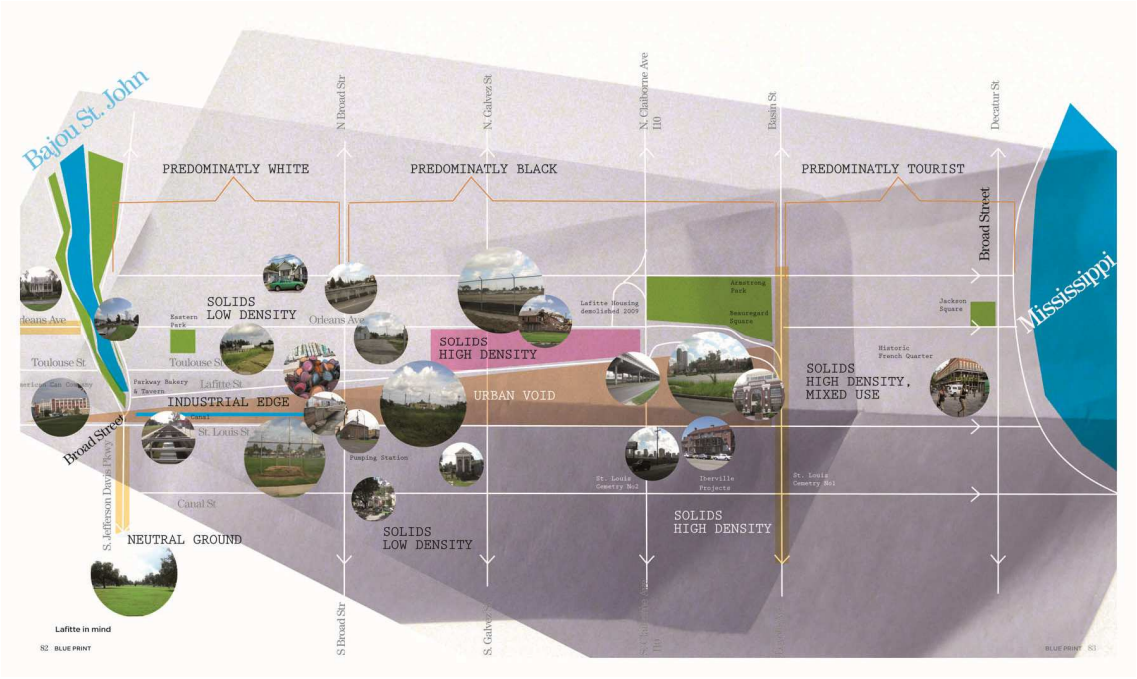

Figure 5: mapping Lafitte Corridor

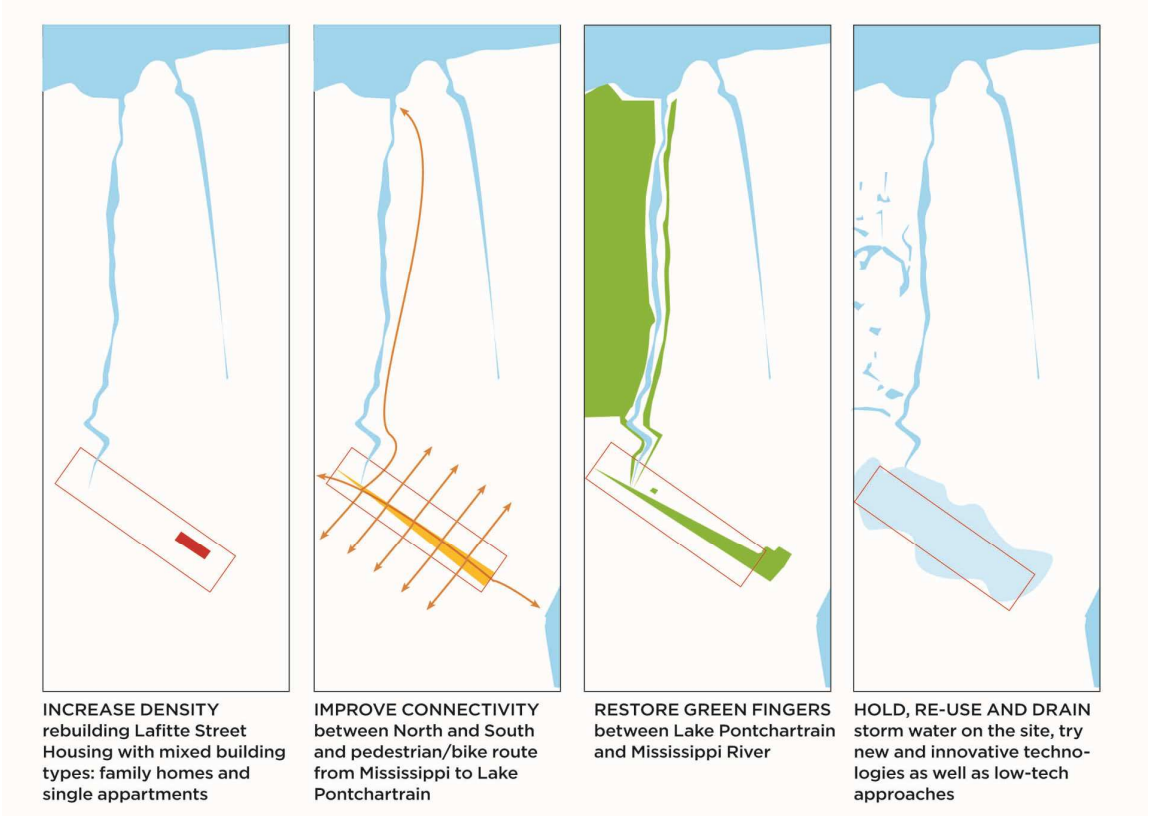

Figure 6: The focus of the urban plan is to increase density, improve connectivity, restore green fingers and hold, reuse and drain storm water on-site.

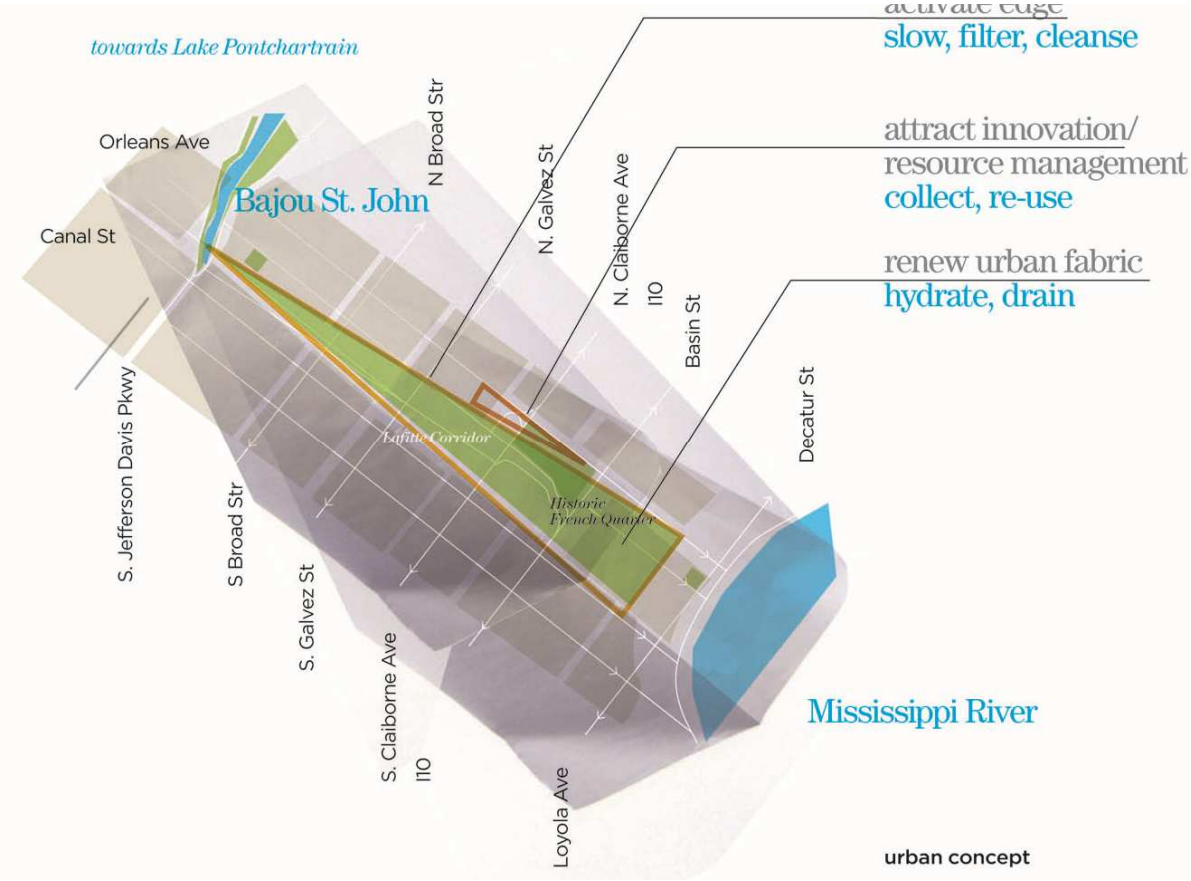

Figure 7: Overlay of the urban concept with on-site water management

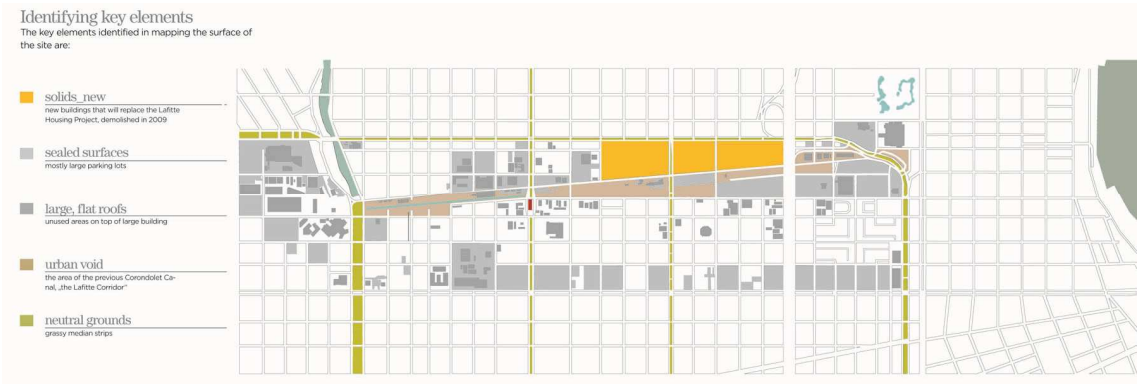

Figure 8: Mapping the surface: mono-functional structures with potential to become multipurpose open spaces. (© 2010 Amiyo Ruhnke)

Figure 9: The design strategy "thickens" mono-functional structures with additional programming and on-site water management.

Figure 10: Neutral grounds with roadside rain garden beautify the urban landscape.

Figure 11: Green roofs store water and add habitats for more species.

Analysing key elements

The key elements that offered potentials for the storm water management were identified with a mapping strategy.

I_New "solids": the new buildings that will replace the Lafitte Housing Project, demolished in 2009

II_sealed surfaces: large parking lots as well as flat roofs, which are unutilized areas on top of large buildings

III_urban void: the area of the previous Corondolet Canal, the Lafitte Corridor

IV_neutral grounds: grassy median strips
All of these are currently mono-functional structures with lots of potential: to enhance the open space quality of the neighborhood as well as to add to the water management.

RETROFITTING CENTRALISED SYSTEMS WITH DECENTRALISED SOLUTIONS

Strategies learned from the networked system of the mushrooms were explored spatially and adapted to the storm water management. The main focus was on adding more capacity and resilience to the water system, both with technological innovations as well as an improved

integration of underutilized spaces in the urban fabric by adding additional programming and water management.

The current mono-functional structures were "thickened" with additional programming and connected to the water system.

I_New "solids": the new buildings will be fitted with innovative technologies such as the HydroSkin, a "closed loop" for the water system approach should be taken

II_sealed surfaces: sealed surfaces serve as retention areas. Additional temporary programming such as skate parks or markets are looked for

III_large, flat roofs: wherever the load bearing structures permit that green roofs are installed, some might have solar panels as well

IV_urban void: the urban void will become an attractive green space

V_neutral grounds: The grassy median strips become rainwater gardens that store and drain surface water from the streets

Wherever possible systems are interconnected across different scales. Impact of storm water management needs to be considered with all scales: from the single plot to the urban and regional scale. The design approach is low-tech. "Fluxfields" can be temporarily programmed or with a future change in mind.

New Orleans' future is – like that of any city – uncertain. All new elements should be reversible facilities, they should be able to be dismantled and transformed, and be able to adjust to the growth and shrinkage of the city. A variety of systems add resilience to the design through diversity, cohesion and adaptability.

TOWARDS THE FUTURE: WILL URBAN LANDSCAPES BECOME PRODUCTIVE INFRASCAPES?

An integrative approach for contemporary urban projects requires "a new kind of synthetic imagination–a new form of practice in which architecture, landscape, planning, ecology, engineering, social policy, and political process are both understood and coordinated as an interrelated field." (Corner, 2004). Understanding natural systems and their networked character helps to develop new process-oriented strategies in the design of hydrological systems in urban areas.

"Infrascapes" transport principles of the cultural landscape into the urbanization process by applying traditional strategies such as a polyvalent use of space instead of mono-functional use, discontinuity and change of functions, differentiation of function on a small scale as well as a blurring of boundaries in which function and urban texture are interwoven. (on principles of cultural landscapes see also Konold 1996). The urban landscape becomes a productive infrascape in which the water management is embedded as a function that adds to the variety and beauty of the open space.

Infrascapes are nested systems and need to be integrated in all scales:

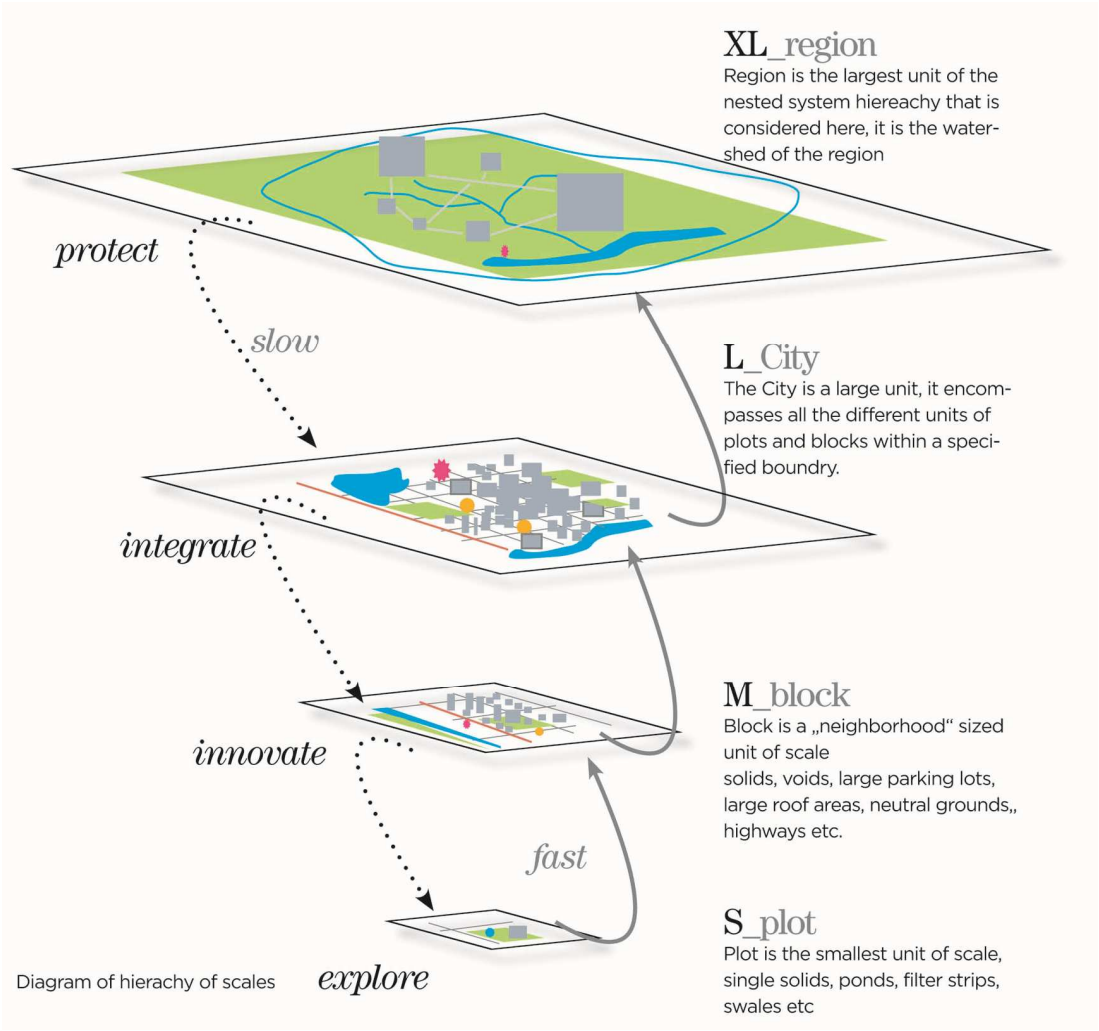

Figure 12: Nested systems connect horizontally as well as vertically through a hierarchy of scales.

Thus the design process becomes a more challenging task as it needs to integrate different disciplines not only horizontally but also vertically. Small scale solutions developed for a specific site need to be connected with a larger scale technical infrastructure. Only interdisciplinary co-planning processes between administration, architecture, urban planning, water management as well as landscape design will help to integrate water infrastructure as part of multifunctional spaces into the urban fabric.

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Sustainable refurbishment as a driving factor of urban regeneration

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ABSTRACT

This article is discussing advantages of the process of refurbishment, how it affects the environment and urban fabric. It also revises a case study of sustainable refurbishment of an industrial building as a successful example of such a conversion. Features of industrial areas in Moscow and particularly the area, where intervention will take place, are investigated. Furthermore, the given conditions of the climate and local building regulations are analyzed. The main climate's responsive strategies are tested with the use of TAS software and then they are applied to the intervention building, where the best performing dwelling was selected. Climate was simulated in order to investigate the energy performance of the intervention building. The results obtained confirm that a dwelling in the refurbished industrial building in Moscow can consume less energy than a conventional one.

Keywords: Refurbishment, conversion, industrial building, urban regeneration, Moscow.

INTRODUCTION

A change of use involving a sustainable upgrade could bring new life not only to a particular building but also to the surrounding area. In general the process of adapting buildings has numerous benefits in architectural, cultural and historic terms. It is for these reasons that building conversions are becoming increasingly important in the developed world.

Schittich, C, (2003) states that refurbishment accounts for 40% of construction in central Europe and this number will continue to grow. The reason for this is because the historical heritage as well as the building stock in this region is quite rich. A significant number of the buildings from different periods and different typologies have either adequate conditions (envelope/constructions/both) or historical value and could be profitably refurbished to the current energy performance standards and beneficially serve their owners.

According to (Douglas, J, 2006) economic growth and urbanization are the key drivers of change in modern developed countries. At all market levels, all of these dynamic factors can

trigger the need for urban renewal programs. Cities have always been living organisms changing according to the requirements of their inhabitants. Nowadays the worldwide tendency is to increase the density of the cities, but if we stop for a second and think what the comfortable density for the city is and to which extend a city could actually "sprawl", we will be reaching another question: Why do we need to "sprawl" them? Why don't we look towards what cities already give us? The potential that buildings have to adapt to changing internal/external conditions allows us to reuse the existing urban density within the city in order to rejuvenate it. Thorough design solutions could help to solve this problem.

KEY DRIVERS OF THE REFURBISHMENT. URBAN SCALE

Retaining the character of a streetscape is best achieved through the adaptation of its buildings. Old buildings offer psychological reassurance because of their distinguishing characteristics (Scottish Civic Trust, 1981). Here is the important point of refurbishment and urban design of the cities: preserving existing buildings helps people to feel more comfortable and homey. It is much more encouraging for the community/people to regenerate the area rather than demolish and try to fit new density within formed neighbourhood.

Another important driver of the refurbishment is the regeneration of the surrounding area. According to (Douglas, J, 2006) sensitive adaptation schemes such as the reuse of derelict industrial buildings can bring back life to run-down urban areas. There is a good example of such a scheme implemented in Moscow for a cultural centre – Winzavod (translation: wine factory). The conversion of a former wine factory in the huge industrial area of Moscow next to the city centre, was completed in 2007. With a project by the Russian architect Alexander Brodsky, the ex-factory buildings were converted into galleries, café and some shops. Gradually this area has become quite popular among people, because of its central location and the quality of the space achieved by simple solutions. It attracted more and more visitors willing to work as well as to socialize in this creative space. The Winzavod is surrounded by two other factories, which following its success, are planned to be converted as well. The whole area is reviving from abandoned industrial zone into one of the main attractions of the capital. This example demonstrates how well done refurbishment solutions could bring new life into derelict areas.

Environmental advantages of the refurbishment

Another advantage of the refurbishment process is the delivery of an energy efficient building. By definition, an upgraded building will be more energy efficient than it used to be. In cold climate the improvement of the fabric of an existing building includes actions such as: insulation and windows' upgrade, air tightness measures, and an optimized heating system which will lead to a significant reduction in energy consumption. A regenerated building could perform better than the conventional houses and even could be compared to the performance of new built houses. So, the benefits from urban regeneration combined with energy efficient buildings are valuable for the community and local authorities.

It is also important to mention that refurbishment can offer enormous pay-offs. For instance, the developer company "Factory Building" explained their approach to building adaptation.

They choose a property in a central location, using simple materials and upgrading solutions (building fabric, windows, flooring and internal finishes). Afterwards the property is sold and due to huge demand for housing or offices in that central location, it becomes very profitable because the upgraded property results more attractive to potential buyers. Additionally: "Delivering low carbon refurbishment doesn't require significant increases in complexity, or adoption of high risk or unproven technical solutions. On the contrary, nearly all refurbishments offer opportunity to reduce carbon emissions beyond the standard set by building regulations" (The Carbon Trust, 2008). From another point of view (Douglas, J, 2006) states that the more complex and old building is the more expensive the process of adaptation will be. This means that in almost every case, the process of refurbishment is more profitable in terms of money apart from those cases when buildings are too old and require additional attention.

It is worth to mention that according to the ASHRAE Handbook (2009): "Reuse of existing buildings is one of the most effective strategies to minimize environmental impact". The building's shell has the highest amount of embodied energy as it requires more material than any other part of the building. As long as the envelope is already in place, the fewer amounts of new materials will be used, therefore preserving the embodied energy within the existing envelope.

When comparing refurbishment with a new build, it is necessary to include in one's calculations that the latter will have to repeat the entire life cycle of the building (material manufacturing, transportation, construction, operating energy and the last stage involves demolishing and recycling) plus demolition (Fig. 1).

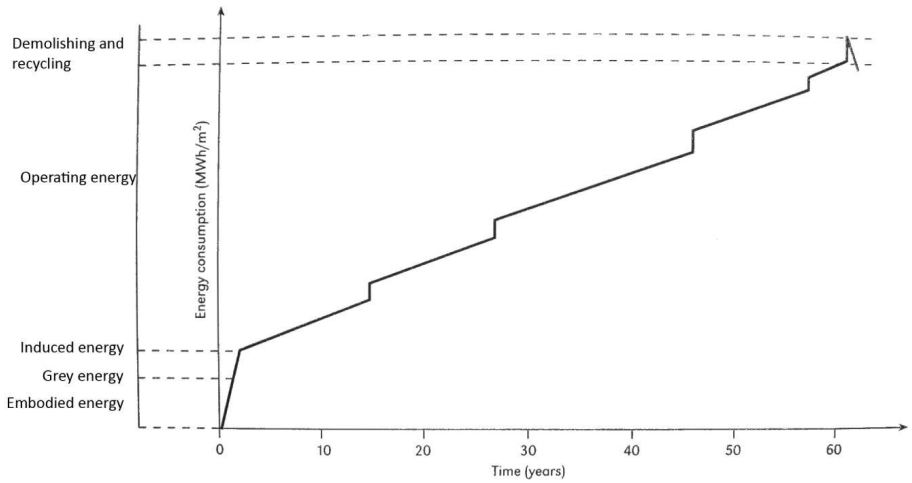

Figure 1.

Furthermore, in a refurbishment project, demolition is completely or partially avoided. The process is expensive and complicated particularly within the existing environment. It also creates waste on the site and consumes a lot of energy. It will always produce unwanted levels of noise which could disturb occupants in neighbouring areas. Therefore, avoiding demolition will bring additional financial and ecological benefits to a refurbishment.

Case study: Brewery in Moscow

Further on, the case study of a conversion will be investigated and the particularities of the refurbishment process mentioned above will be checked here.

Climate in Moscow

Disadvantages	Advantages
Severe outdoors conditions half of the year	Comfort and evenly warm summers
Cold winds	Relatively low cooling loads
Low levels of solar radiation	
Low sun angles	

The main concern while designing buildings located in cold climates is to protect the envelope from heat losses. In Moscow, the heating period spans for about 7 months a year and it has an average winter temperature of -10 C^o (Fig. 2). Further insulation improvements without effective solutions for the control of air tightness will lead to an inefficient insulation performance. As the winter is too cold and the level of solar radiation is low, passive solar heating cannot replace conventional heating. But for midseason months like April, September and the beginning of October, when the temperature and the amount of solar radiation rises, this can partially reduce heating loads.

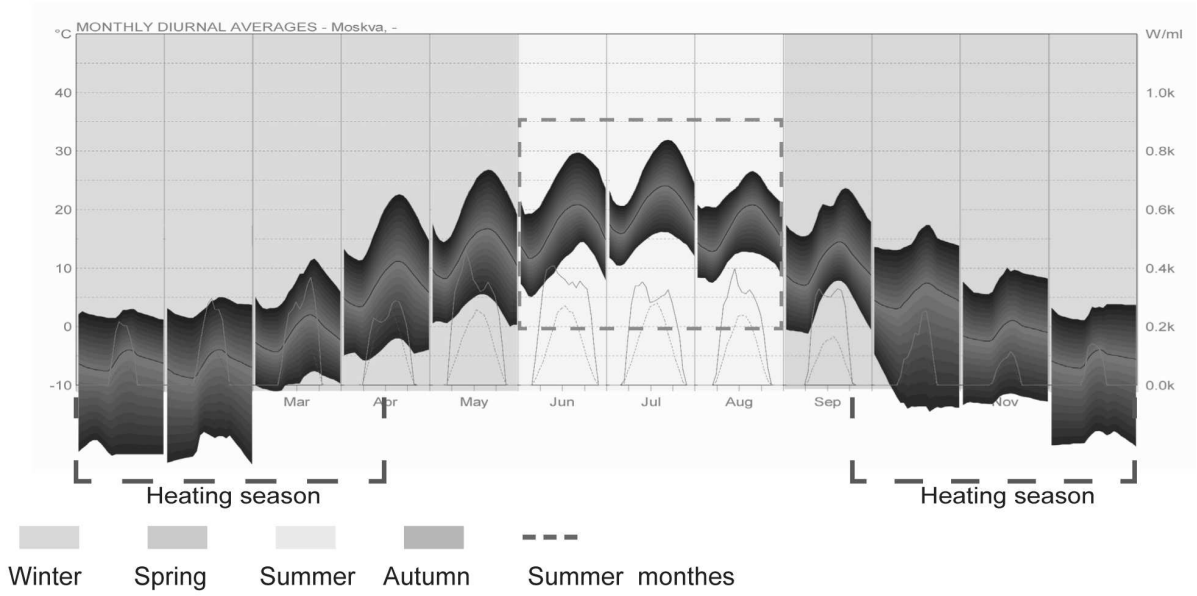

Figure 2. Temperature in Moscow.

The problem caused by cold outdoor conditions is not just physical discomfort due to low temperature, but also psychological discomfort which, according to (Rogers, P, 2008), occurs because occupants have to spend most of the time indoors and with a lack of solar radiation. People become depressed and their productivity drops. Thus, one of the simplest solutions is to create spaces protected from outdoor conditions where people can meet or spend some time like an atrium or a buffered space.

City context

Usually cities sprawl from the historical centre to the suburbs and Moscow is no exception. At the end of the 19thcentury, during the rapid industrial growth in Moscow, a lot of industrial buildings and industrial areas were created towards the suburbs. Numerous residential buildings were built around factories to house workers and their families. Around 1955 new residential areas were built, but, for some reason, industrial areas were overrun and they became surrounded by residential districts on all sides. (Topchii, D, 2008) This is when the city developed a similar skyline to what it has now; the historical part of Moscow is surrounded by a ring of industrial zones.

Nowadays, according to a research study by the company "Miel' – New Development", industrial areas in Moscow occupy 19.3% of the city's area. This is equal to 20,900 hectares– the total area of the city being 104,500 hectares. In comparison, in Europe this number does not exceed 10%. A large percentage of those areas are abandoned for different reasons. One of the main ideas highlighted in the "future development of Moscow" (a general plan for the city by 2025) is to reduce the extent of industrial areas from 20,900 hectares to 7,000 hectares.

The conclusion makes evident that, Moscow has a significant stock of industrial buildings available, and many of them are real masterpieces of industrial architecture.

Description of the district and its future development

The site was selected out of the industrial ring mentioned above. It is situated in the western administrative district called Dorogomilovo on the riverside of the Moskva river (Fig. 3). It can be characterized as a very prestigious area of Moscow with very high prices for both housing and offices. The area is traversed by one of the main highways in Moscow: the Kutuzovsky street; it also contains a number of tube stations and one of the main railway stations in Moscow: Kievskaia station.

The area contains both residential and public zones. On the opposite side of the river the biggest office development in the city is situated, known as Moscow-city. Because of these factors, any development in this area has a great potential for success. It was crucial to identify which use will not create a big impact on the existing context. Thus, a mixed-use residential/office scheme was chosen as the most appropriate, as the site is mostly surrounded by dwellings. There is also a demand for creating green buffer zone because of the site's proximity to the highway.

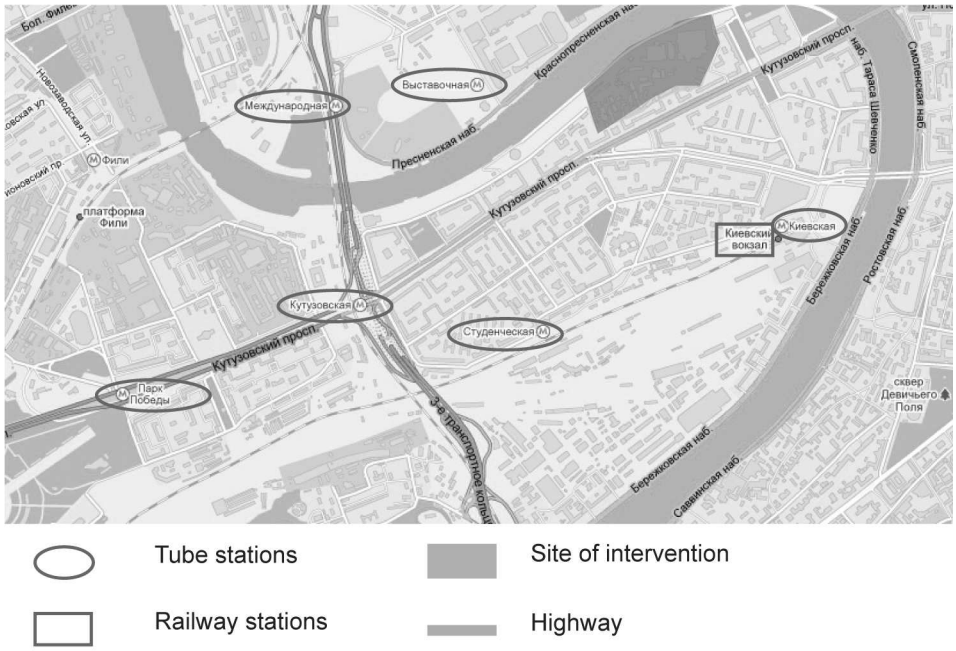

Figure 3. Site location in the Dorogomilovo district.

Site description

Currently, the site coverage is 40%, as some small buildings have been already demolished. Buildings are grouped in the northern part of the site and are not obstructed because the southern part is not built (see Fig. 4). It is likely that the existing density of the site will be saved in future developments as the government plans to convert part of the existing buildings into a hotel and to create a park in the south side.

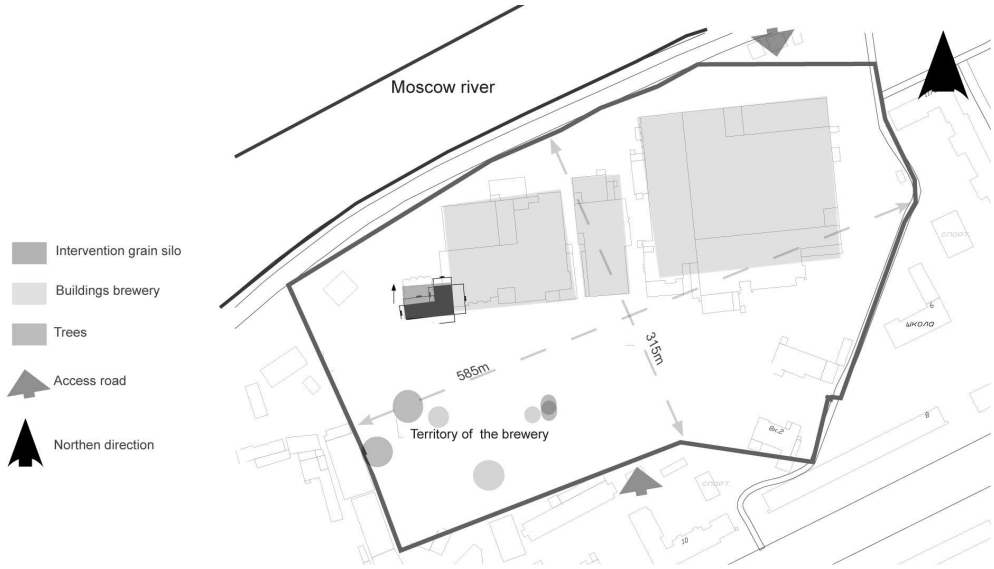

Figure. 4. Scheme of the site.

The construction of the brewery was completed in 1876. Some parts of the brewery were added later on as well. All of the old buildings have brick load-bearing walls, while more recent buildings have concrete structures. They all are oriented on the South-North axis, with a 5^{o} deviation towards West.

Nowadays the brewery is operating partially. There is also rental space for offices, cafés and car washes. A few buildings within the complex have no use and have been abandoned and left to dilapidate.

Building description

Main building issues:

- Thick, un-insulated walls.
- No windows on half of the façade (because of the wall's thickness, it will be difficult to open voids for new fenestration). Some existing windows are broken.
- Malting wells have iron netlike slabs (which were used for drying malt). The slabs are not opaque and meant to bear heavy loads.
- The overall depth of silos is 24 m.
- The south façade extrudes above and overshadows malting wells.

Possible solutions:

1) Adding new fenestration will be a necessary measure in the conversion of the silo. In order to reduce unnecessary work, it is important to make only the required new windows (according to the analytic work, window-to-floor ratio should not exceed 15-17% in this climate). All the old windows should be replaced.

2) Improve floor slabs where it is needed.
3) Open an atrium in order to solve the problem posed by the extreme depth of the silo.

4) In order to have direct light in the atrium, its windows and skylights should face west.

Implemented strategies were used

1) For economic and energy efficiency reasons, double glazing with night shutters is more appropriate.

2) 15-17% w/f is optimum in terms of solar gains and loads. In a Swedish passive house (information based on a paper of Janson, U, 2008), for example, w/f is 16%. Lower or higher ratios increase and decrease heating loads accordingly, but, a 20% w/f ratio can be applied as a worst case scenario.

3) South/north orientation is the most efficient. If the building is oriented on the west/east axis, heating and cooling loads should be carefully considered.

4) Cross ventilation can reduce the cooling loads twice as much.

5) Single exposed flats require only 70 mm of insulation because of its compactness.

6) Schemes should not have more than three or four exposed walls only when there is no other solution, and they should be considerably protected.

7) The effect of thermal mass is quite small as the building uses continuous heating system rather than a passive solar heating system. Nevertheless, thermal mass have a positive effect on cooling loads during summer.

8) Flats with one wall exposed will need only 70 mm of insulation.

Open an atrium

Because of the building's deep plan configuration, it was decided to locate an atrium in order to open up the central part. It divided the building into two parts, which are 6 m and 7 m deep respectively. This depth, according to the CIBSE guide B (2006), will increase the chances of cross ventilation. This will be enhanced by the natural stack effect provided by the atrium's configuration. These measures combined will ensure the desired fresh air provision and cooling loads' reduction. The atrium could also serve for winter time ventilation, as flats face the space which is protected against outdoor conditions.

The atrium is 12.5 m by 6 m, which will allow daylight to enter on the lower levels. It will provide access to the flats through a common balcony. Each floor will have a common space of 20 m^2 where people could meet and socialize.

Skylights above the atria face west, as the southern sunlight will be obstructed by that part of the building. There are also six windows (1,000 mm by 1,200 mm) opening on each floor to the atrium's west façade, which will provide direct sunlight during the whole year. Their size was calculated in order to avoid any extra heat loss.

Figure 5 presents sun path diagrams for all five floors of the atrium. It demonstrates that floors 4 and 5 will have direct sun from the South during summer. All the floors will have direct sunlight from the West during the entire year.

Thermal performance of the atrium

The atrium is meant to be unheated. Its surrounding walls have 200 mm of insulation and all the windows are double glazed. During winter, the atrium is assumed to be closed and naturally ventilated for one hour during the day. Being the outside temperature higher in the afternoons because of solar radiation, it represents a good opportunity for natural ventilation.

The thermal performance of the atrium in winter is presented on the Figure 6. Generally, the temperature in the atrium is about 10^{o} C higher than the outside temperature. There is a 5^{o} C drop in temperature when the atrium is ventilated. In conclusion, it can be mentioned that the

atrium can be used for winter ventilation, as it gets higher temperature than outdoors. It could also work as a protected space, where children can play.

In summer, the atrium is fully opened 24 hours a day and it is meant to work as a courtyard. Although overheating could occur when the outside temperature is above 28^{o} C in summer, night time ventilation should take place in order to reduce such possibility.

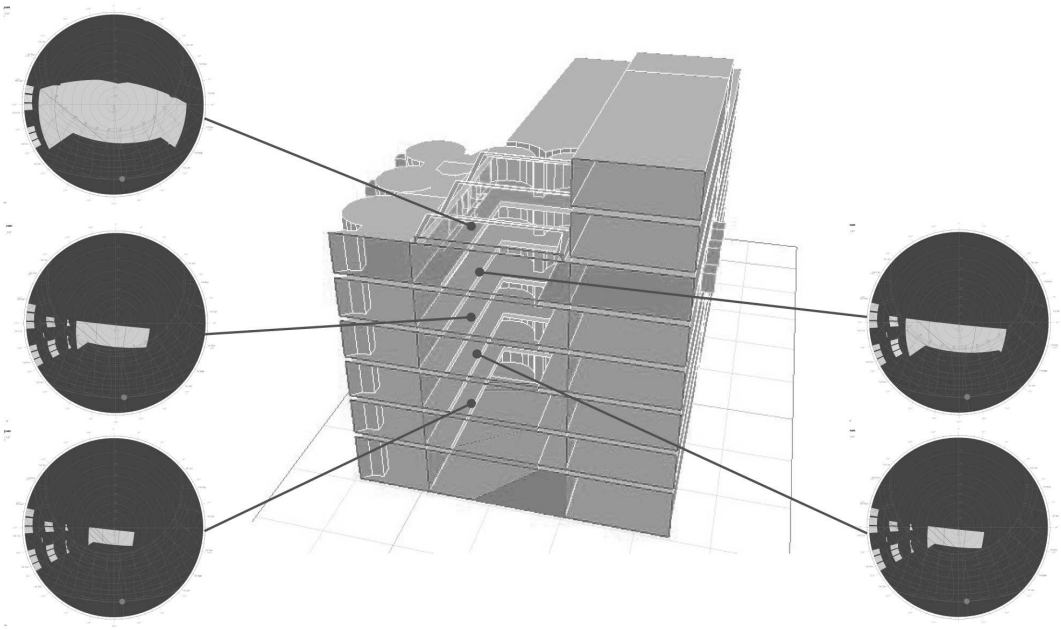

Figure 5. Sunpath diagram for all five floors of the atrium.

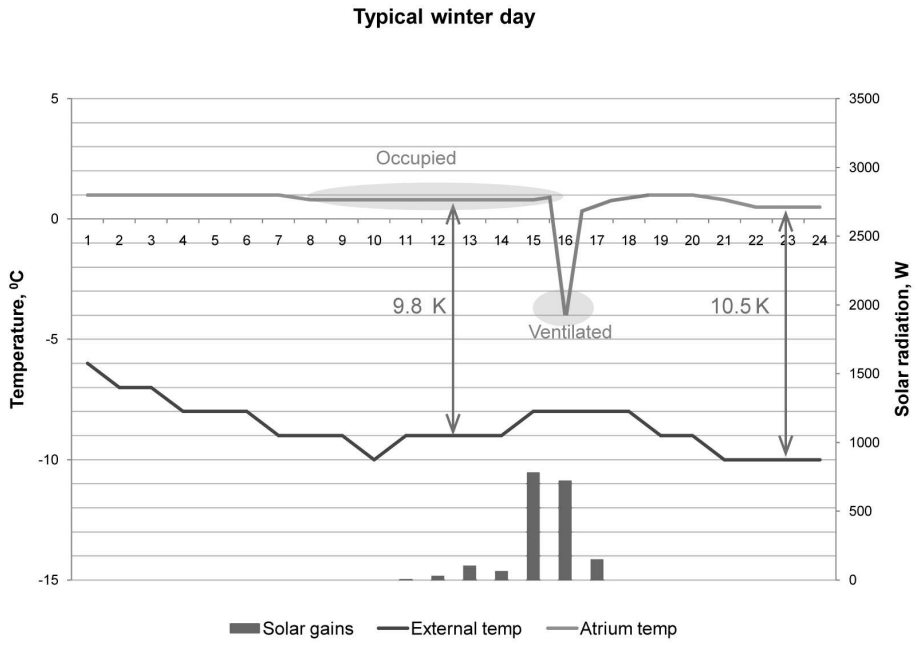

Figure 6. Thermal performance of the atrium in winter.

Best case

One of the flats was assumed as the best case in terms of thermal performance. Flat A is located on the 4th floor (Fig. 7) of the building's south wing. It is defined as best case, as it is oriented south, it has only one wall exposed to the outside with 70 mm of insulation, and the opposite one facing the atrium has 200 mm of insulation.

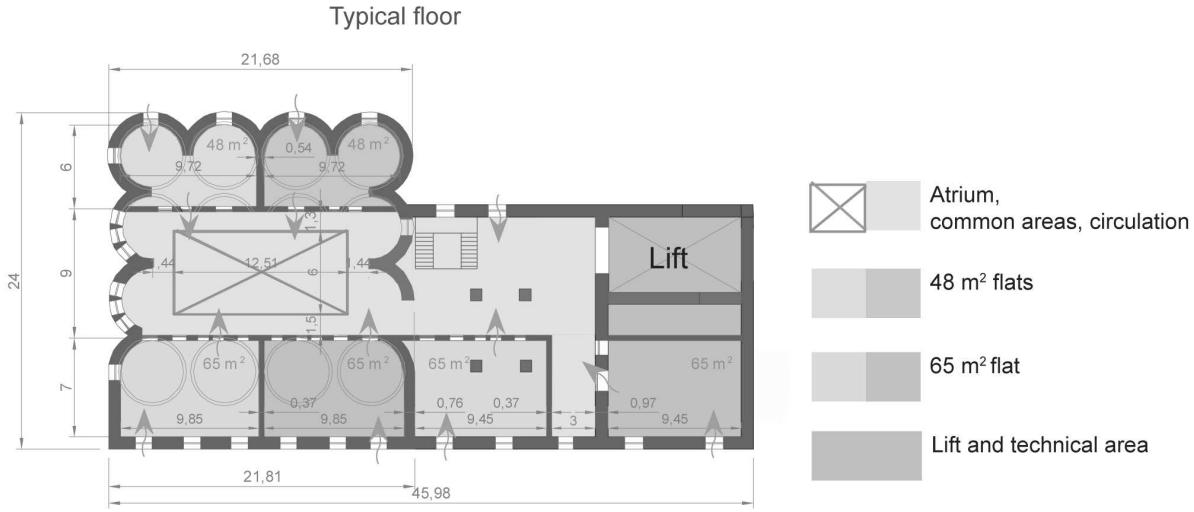

Figure 7. The 4th floor.

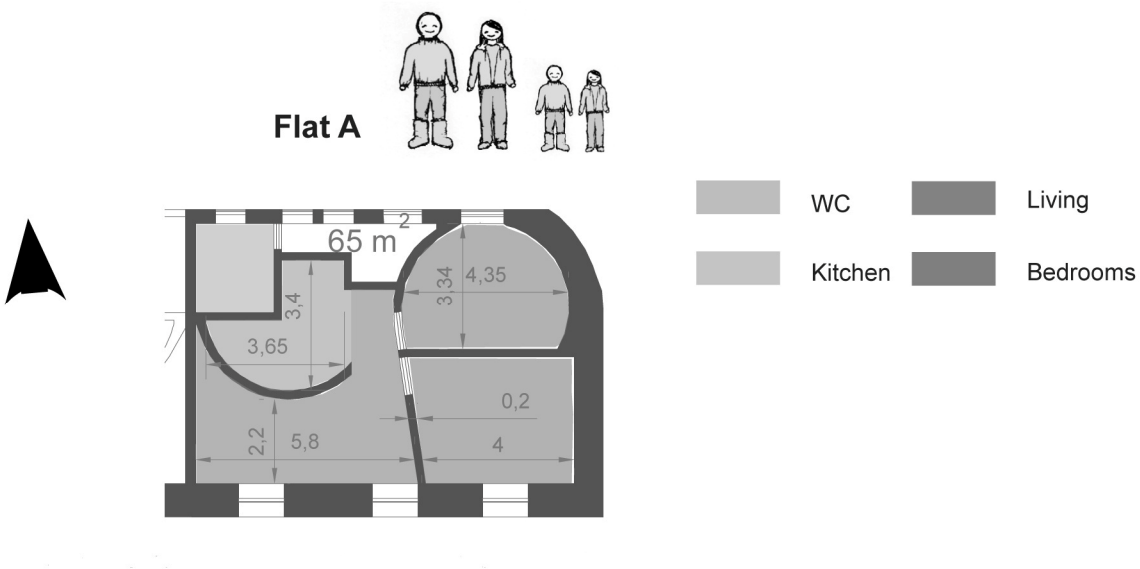

Figure 8. The flat A.

For simulation purposes, an approximate space distribution for the flat was made and its occupancy defined. Flat A (Fig. 8) will have a family of four, with two people continuously staying at home and two others occupying intermittently for 12 hours a day.

The thermal performance of the flat as per the dynamic thermal simulations conducted is described as follows:

Flat A:

- Area: 65 m^2
- Volume: 175,5 m^3
- Floor to ceiling height: 2,7 m
- Window to floor (W/F) ratio of the flat is 15%
- Exposed envelope/floor ratio: 0.4

Total heating loads for the Flat A are 35 kWh/m^2 yearly; the total cooling loads are 3 kWh/m^2. Heating loads are low because the flat is compact.

HEATING LOADS

A benchmark for heating loads (43 kWh/m^2) established from the analytic work and based on Russian building regulations (SNIP, 2003) was used to compare with the heating loads of the flat A, and a reduction of 8 kWh/m^2 was observed. This reduction could be explained by: winter ventilation through the atrium and a thicker, better insulated wall with lower U-values, respectively (Fig. 9).

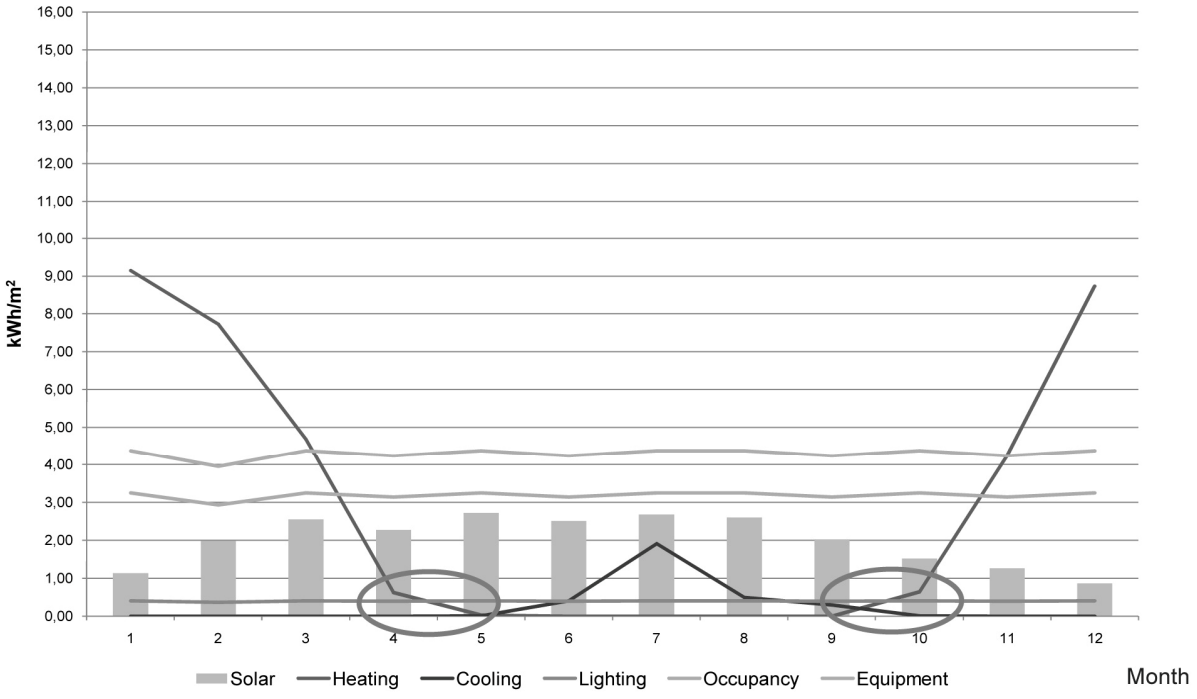

Figure 9. Flat A, monthly loads

Solar gains

It was observed on the graph that solar gains are quite low in this flat (24 kWh/m^2 yearly). Such a low value could be explained by the wall thickness, which allows for a smaller amount of heat generated by solar radiation to get into the flat by conduction or convection. Albeit in summertime such amount of heat coming from solar radiation is diminished as well, this flat will need shading devices as an additional measure in order to reduce cooling loads further.

As it can be seen on the graph, heating loads in midseason months are very low because the building becomes less responsive to outside conditions and effect of solar gains becomes more significant. As heating loads in April and October are very low, further improvements in energy performance will result in a complete avoidance of active conventional heating during these months.

The goal of these thermal simulations is to see how much energy will be consumed on the best performing case in the converted building and the results obtained are very promising. It is clear that the atrium solution worked very well in the climate of Moscow, particularly because the atrium is free running mode and do not consume energy for heating or cooling.

A similar situation occurs with air tightness. It is clear that further improvements in air tightness and consequently, the use of a mechanical ventilation system, could bring even more reduction in heating loads.

Other strategies such as compactness and orientation were confirmed to be important in a climate like Moscow's.

Generally, the idea was to see how a building of such typology would respond to energy efficient improvements and if these results would be reasonable in terms of energy consumption.

Daylight performance of the flat

The proposed space distribution of Flat A (as defined before) was tested using the software Ecotect in order to see how it will perform with an overcast sky with an illuminance of 4000 Lux (as a worst case scenario) – see Figure 10. Daylight levels were observed and, according to the benchmarks established in the CIBSE Guide A (2006), further conclusions drawn. In winter, daylight levels are generally low and are caused by the geographical characteristics of Moscow rather than its design flaw. During summer, the daylight levels of the flat are much better, except for the middle part because it is separated by internal partitions.

This leads to the conclusion that the problem may relate more to the distribution of daylight rather than to its levels. It is clear that internal partitions could create problems with daylight distribution. This means that daylight distribution could be solved using simple measures, such as adding fanlights into internal partitions.

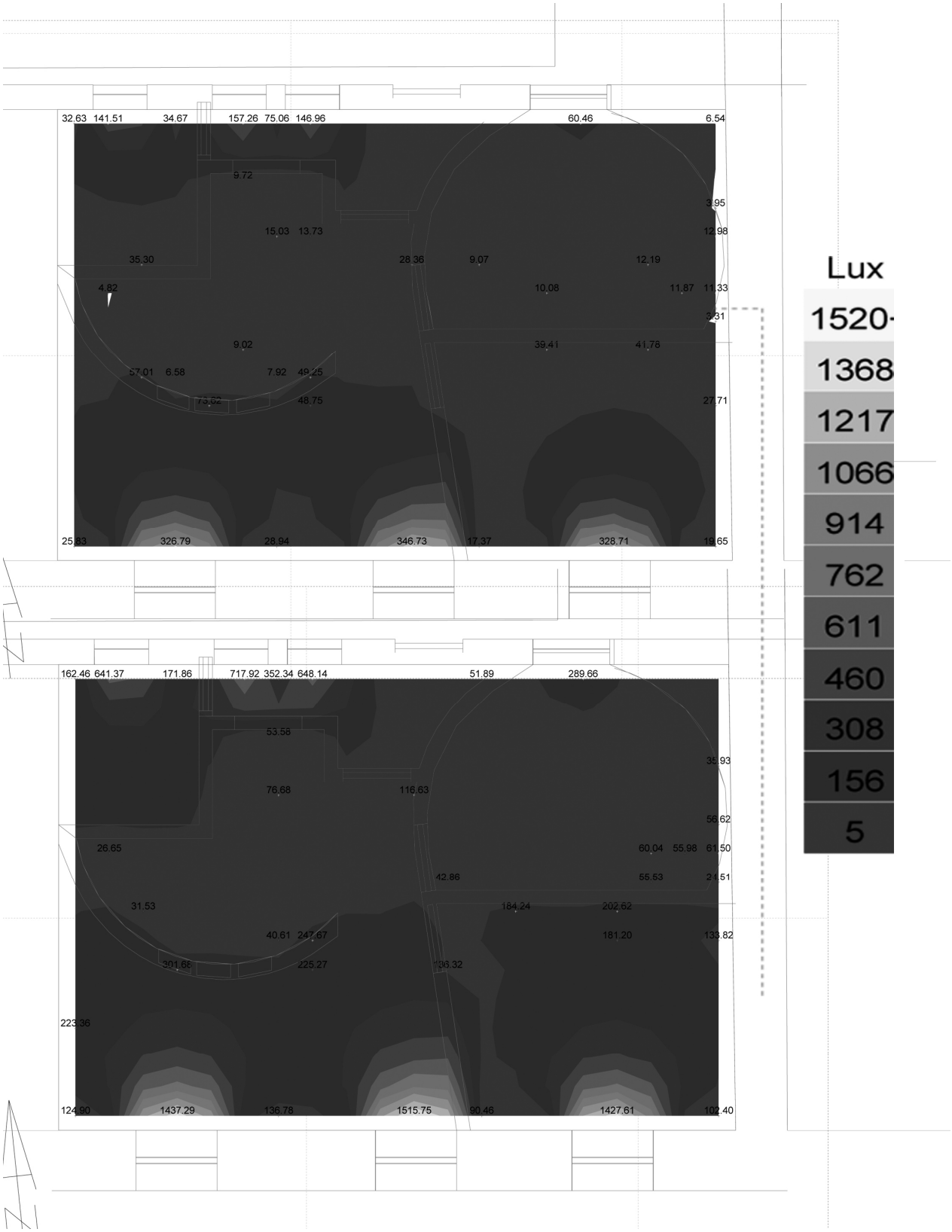

Figure 10. Flat A, comparing daylight in December 22nd and June 22nd.

Comparison with the other performances

The case study observed in this article for a refurbished flat is a significant step towards energy efficiency in Moscow's houses and in Russia generally.

It was clear from the beginning that flats will not perform as good as the Swedish passive house (which was selected as a reference because they both are located in a similar climate). The Passive house standard stipulates a very airtight new construction along with a heat recovery ventilation system. However, it was interesting to establish whether reduction in heating loads could be comparable to the passive house standard (Fig. 11).

Flat A had 69% reduction in heating loads and it is a very efficient example, as it has an even higher percentage in terms of reduction of heating loads than the Swedish passive house.

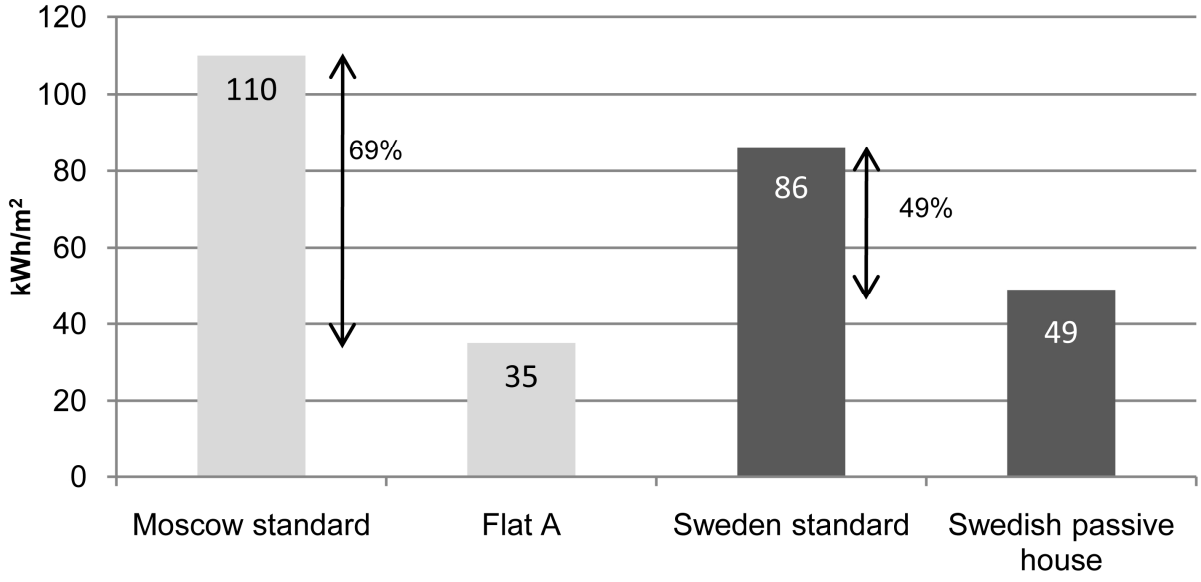

Figure 11. Comparison of heating demands of a Moscow's standard flat with flat A, versus comparison of heating demands of Sweden's standard house with Swedish passive house.

CONCLUSION FOR THE PROPOSED INTERVENTION

The lack of energy efficiency considerations is a direct result of the current situation in the Russian building sector. For this reason, demolishing and constructing new buildings is still assumed as the easiest solution; this sometimes occurs even with listed monuments.

Opportunities provided by refurbished buildings confirmed that in general the advantages of refurbishment exceed their disadvantages. This research aimed to demonstrate that refurbishment might be a better solution, particularly in the context of the existing urban fabric.

The article was aiming to study how well a converted building could perform. This was done in order to highlight an applicability of the building conversions. How simple measures could revitalize the whole area around. The case study shows how the existing density of the area can be preserved by bringing a new life to a building.

The proposed intervention could be difficult in terms of construction, but numerous precedents of silo conversions confirm the feasibility of the proposal. Ultimately, it is obvious that any new use applied to this kind of building will require a partial demolition of the existing structure. Nevertheless, the payback period for this building could be quick, as the real estate value in the area rises, as it gets developed.

The idea that, converted industrial buildings could become very exceptional and attractive dwellings with a greater spatial quality than typical flats, becomes a particularly significant objective in the context of Moscow, with its dull conventional residential blocks.

ACKNOWLEDGEMENT

First of all I want to acknowledge all the members of my family, particularly Roman Khripko and Margarita Novikova for their help and support. I want as well to express my gratitude to Eleni Tracada and Chris Forby. And I also would like to acknowledge Alfonso Hernandez, Mili Kyropoulou, and Didar Ozcelik for their support.

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Part B – Papers selected by the Editors

A Vision for the Future of Havana

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ABSTRACT

The Havana Master Plan aspires to recreate a pedestrian friendly urban ambience that encourages outdoor living – according to Cuban's idiosyncrasy – and social and cultural integration where people can meet, work, relax and enjoy. It consists of a number of pragmatic considerations and proposals expressed in concrete projects supported by contemporary urban theory and studies and also based on the past plans with their virtues and failures. It is also based on the experiences obtained in numerous travels abroad – including the United States of America, Canada and Europe – and the exchange with qualified planning professionals from different latitudes.

Keywords: Havana, 21st century Master Plan, Caribbean metropolis, spirit of the place.

A VISION FOR THE FUTURE OF HAVANA

Introduction

Havana, a Caribbean Metropolis with a European influence, was spared the damage of the global urban renewal and overdevelopment of the second half of the 20th century. Even today, it still keeps intact its traditional urban fabric. Its unique and appealing spirit stems not only from the well-known quality of its music and rhythms, its vibrant street life and its friendly ambience, but also from its built environment. However, the city's harmonious juxtaposition of different architectural styles, displayed by an impressive collection of buildings authored by world famous local and international architects is currently threatened by overdevelopment, sprawl and neglect. This unique ensemble shows how good and humane urbanism makes possible the coexistence of buildings from different periods that follow guidelines and ordinances that have made their survival possible.

A comprehensive Master Plan aimed at preserving the city's spirit and its historic, urban and architectural legacy has been devised to foster Havana's future urban and economic development, while remaining true to its history, its people's idiosyncrasies and its

landscapes. The plan acknowledges Havana's readiness for a sensitive change and renovation according to sustainable principles that reconcile human needs with ecological imperatives and envisions Havana's survival as an urban place with a strong cultural identity. For the first time, it supplies a long term vision that guarantees total connectivity and a seamless urban layout.

Cuba: The Key to the New World

Christopher Columbus exclaimed "This is the loveliest land ever beheld by human eyes" upon his arrival in Cuba in 1492.

From the standpoint of urban planning, the process that followed was unprecedented since the days of the Roman Empire. In the early 16th Century, Diego Velazquez founded seven settlements, so called *villas*, along the island's coast whose primitive layout was based mostly on geographical features. The settlers were pragmatic and the new cities, towns and buildings were shaped by the need to adapt to local climatic conditions, the availability of local materials and the progressive assimilation of European urban and architectural models together with the mark left by immigrants from all over the world. These influences helped mold a culture with a highly distinct architectural heritage spanning over five centuries that reflected the country's development and defined its cultural identity.

The Spirit of Havana: Genesis and Evolution

One of the original seven *villas*, Havana was definitely settled by its protected harbor in 1519 after two previous attempts. The key geographic position of its port eventually allowed the fast growing commercial activity of the Spanish fleet and the development of an expanding shipbuilding industry. These features soon granted the city the highest prominence among the overseas colonies playing a major role between the Old and the New World and in turn motivated Spain to build fortresses to defend Havana from the attacks of pirates. Castles, convents, churches and palaces were constructed by European military engineers and craftsmen and became the first beacons to delineate the urban landscape of Havana's medieval grid of narrow and shaded streets, breathing through a network of *piazzas* and *piazzettas*, which would establish the early polycentric character of the city. In 1603 Cristóbal de Roda laid out Havana's first urban plan outlining the walls that later enclosed the city. Subsequent plans, especially those drawn after the English Navy temporarily captured Havana in 1762, were conceived with a similarly military character. In the architectural realm, buildings centered on courtyards, a style adopted by Spain from the Moorish tradition, were gradually accepted as the adequate typology to deal with local climatic conditions.

The first significant urban changes of the early colonial times took place in the late 18th Century, with the transformation of the *Plaza de Armas* into Havana's first civic center and the laying out of public promenades – the *Alameda de Paula* and the *Alameda de Extramuros*. These projects updated Havana's image according to European trends as the spaces they created for the appreciation and enjoyment of nature in the city added a new meaning to Havana. The transformation of the original military parade ground into a civic space had a particularly strong effect on the evolution of the city's *Genius Loci*, by juxtaposing

magnificent newly – constructed Baroque style palaces with the existing Renaissance style Royal Force Castle.

Figure 1. Havana's layers of History (© J. C. Pérez Hernández)

Havana in the 19th Century was characterized by prosperity and splendor based on steady economic growth. The existing colonial urbanism was overtaken in terms of urban expansion and continuity, as well as strategic needs. Progressive institutions favored an ambience of openness to science, technology and management that helped to insert Cuba into the world economy and allowed Havana to adapt to multiple changes. Culture reached broader sectors of society and fostered the gradual consolidation of a strong sense of identity. In architecture, Neoclassicism was embraced as the new style and expressed an aspiration to order, rationality and perfection.

Colonel-engineer Antonio María de la Torre's *Plan de Ensanche* (1817-1819) guided the expansion of the city beyond the walls in an orderly manner by using the existing layout of the roads that connected the walled city with the countryside. This plan was the model for the main arteries with sheltering Neoclassical style porticoes, called *calzadas*, that became the most distinctive feature of Havana's new streetscape and stood in clear contrast with the character of the walled city. Notwithstanding the first modern urban transformations in terms of scale and design were conducted during the term of Governor Miguel Tacón (1834-1838). Anticipating Baron Haussmann's Parisian boulevards, he achieved the redefinition of

Havana's urban landscape in a monumental style with the construction of wide straight avenues and walks decorated with fountains and statues.

In the first half of the 19th Century, along the *Calzada del Cerro*, the affluent bourgeoisie built a series of free-standing Neoclassical villas, called *quintas*, with gardens and porches that served as a model for the new district of *El Vedado*, designed by Luis Yboleón in 1859. This plan emphasized order with a regular grid defined by tree-lined avenues along which lots were laid out. The buildings' frontage featured a five meters deep private garden and a four meters deep porch, allowing for the primary separation between the public and the private realms. This ensured privacy and created a very distinct streetscape. New recreational facilities, such as restaurants, theaters and outdoor cafes, appeared along the former *Alameda de Extramuros*, renamed *Paseo de Isabel II*, following ordinances adopted in 1861. The latter also regulated new districts such as The Ring of Havana (The Walls Subdivision), developed by military engineer Juan Bautista Orduña in 1865 after the demolition of the walls in 1863, echoing metropolitan models from Europe.

El Vedado and The Walls district, marked the birth of modern city planning in Havana. Furthermore, the development of the Malecón by US engineers Mead and Whitney in 1901 reshaped Havana's waterfront image and became an iconic boulevard showing Havana's capacity to reaffirm its *Genius Loci*.

An Expanding Caribbean Metropolis

From the beginning of the 20th Century, land speculation and a lack of comprehensive planning control led to sprawl and the loss of Havana's traditional character of mixed public/private use. New suburbs spread westward from the city, mostly influenced by the United States model based on the use of the automobile. Several plans were put forth unsuccessfully by local architects who attempted to address the scarcity of greenery and the traffic congestion due to a poor road network. In central areas of Havana, like the *Paseo del Prado* and the *Parque Central* zone, new building techniques introduced from the United States of America, such as reinforced concrete and steel frame systems, were used in the construction of representative buildings for different regional groups from Spain. Because their scale was different from that of the existing buildings, these structures had a major urban impact.

In 1926, the Cuban government commissioned French landscape designer J.C.N. Forestier to draw up an embellishment plan for Havana. The plan was based on a network of rectilinear boulevards intended to facilitate traffic and shape the new monumental image of Havana by visually and physically linking important landmarks. Although Forestier's plan was only partially realized, by the 1930's Havana was already an expanding Caribbean metropolis with a compact center, a well defined urban fabric and a very distinctive streetscape with a vibrant street life reaffirming the spirit of the place.

During the Second World War the boom of the Cuban economy extended through the 1950's. In Havana, this period was generally characterized by excellence in architectural design and construction, as well as the presence of an elite group of international architects who visited and lectured like Gropius, Neutra, Mies van der Rohe and Philip Johnson among many others.

There were, however, some threats to the city's integrity. The National Planning Board, created in 1955, commissioned Josep Lluís Sert's Town Planning Associates to prepare a new urban plan. This project neglected the legacy and spirit of Havana by including an artificial island with hotels and gambling casinos for Americans across from the Malecón. If built, this would have had a negative effect on the spirit of Havana by causing a major change in the character of the waterfront.

After the Revolution in 1959, Havana's urban development was stopped in order to favor the rest of the country. The master plans developed by the state's planning agencies in the 1960s and 1970s were merely a reflection of the government's economic and social programs and they imported into Cuba prefabricated stereotypes from Eastern European countries that were incompatible with the existing urban context. These new methods were supposedly a massive solution to housing needs and caused several zones of Havana to undergo radical transformations, the most regrettable of these being the loss of the traditional grid. There was also an increase in sprawl, due to the appearance of new satellite neighborhoods, following a negative trend in international urbanism. These neighborhoods had no mixed use and lacked connections to the rest of the city, as well as green spaces and public spaces. Transportation, infrastructure and housing were not addressed appropriately and still remain unsolved problems today. Thanks, however, to the relatively limited scale of new construction during this period, the spirit of the place was not lost.

In the late 1980's the collapse of the Soviet bloc brought a wave of foreign investment and other real estate projects outside the central areas of Havana. Again, these plans neglected the traditional mixed use character of the city and thus created dead zones by promoting the segregation of functions. Like the American architecture from the mid 20th Century, notably the Miami style hotels, these new projects created a hostile environment devoid of a recognizable spirit of place. These buildings, with curtain walls and low ceilings, have no shutters or balconies to shade and cool them without air conditioning. They also ignore the zoning and building bylaws for they are totally unrelated to the Cuban climate, economy, local building materials and lifestyle. The unfortunate outcome of these insensitive interventions is that they call into question the spirit of Havana. Their impact may become irreversible in the near future if Cuba is assimilated into a new market economy as increasing numbers of these projects are likely to appear when developers and foreign business people pursue money-making opportunities in Havana.

The Hope for the Revival of the Spirit of Havana

The unique and appealing spirit of Havana is a celebration of urbanism and architecture, ever incapable of remaining still, connected to all of the world's cities and at the same time maintaining its own magic and poetic urban identity.

Havana skipped the worldly injurious urban renewal of the second half of the XX century but it is currently endangered not only by climate change but also by an eventual market- driven overdevelopment. Havana features compact city blocks, mixed-use buildings, and lacks traffic jams and multi level highways and has managed to keep its original personality and is now ready for a sensitive change and renovation according to sustainable principles. When

thinking of how to revive unique places, we can learn many important lessons by looking at their past and by connecting with their spirit.

A team of Cuban architects, led by this author, has designed a Master Plan aimed at preserving the city's spirit and its historic, urban and architectural legacy, while encouraging its future urban and economic development. The urban plan expresses a holistic vision that is independent from the government's ideas and from the official planning agencies that replicate the official mandate. It looks toward Havana's future while remaining true to its history, its people's idiosyncrasies and its landscapes. For the first time, it provides a comprehensive scope, spanning both urban planning and urban design, in such a way as to give continuity to Havana's traditions and to seek a contemporary image.

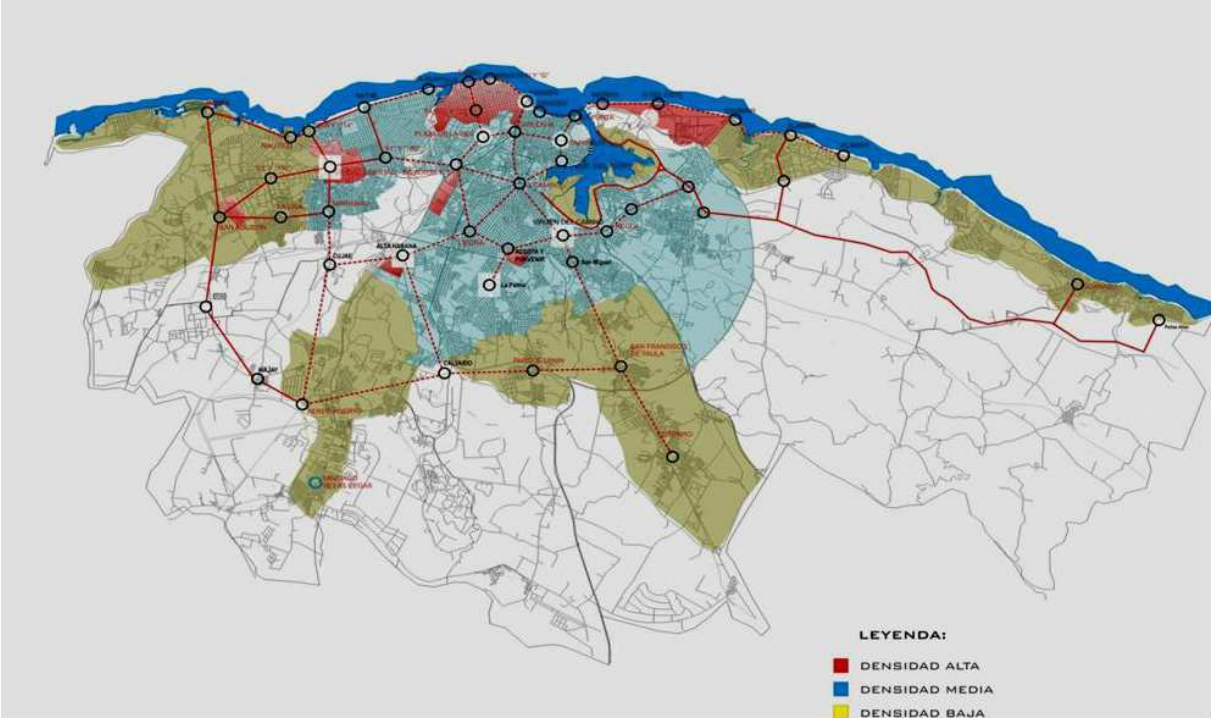


Figure 2. The Master Plan (© J. C. Pérez Hernández)

The Plan is mostly based on ten key concepts that call for a holistic approach.

1. Waterfront Revitalization: A waterfront helps to define a city's image
2. Reinforcement of Havana's Polycentric Structure: A key to the city's identity
3. Increase of Public Space: An real necessity and a must
4. A New Public Transportation System:
5. Infrastructure Upgrading
6. Mixed —use development: Guarantees a livable human environment
7. Social and Cultural Integration
8. Redevelopment of the Traditional *Calzadas*

9. Increase of Green
10. Urban Infill

The Master Plan envisions the waterfront redevelopment as a key concept to achieve a new urban image of the city. It aims to develop the structure of both urban spaces and buildings by orienting them towards the sea in a way that its presence is felt even inland with seafront boulevards, squares, parks and promenades that will help create a new streetscape and a pedestrian friendly urban ambience that encourages outdoor living and social and cultural integration. Considering climate change issues of the utmost importance, the plan envisions urban infill with reasonably high densities. The intention is to encourage outdoor living, as well as social and cultural integration so that people can meet, relax and enjoy city life. Public space combines both high quality outdoor space and fine art, where strolling, jogging and sunset watching support a vibrant, livable and sustainable community life. The whole waterfront area has been divided into sectors for a detailed study and for concrete proposals showing the attributes, existing conditions and potential for future development.

The harbor sector is considered the most important one and it helps illustrate both the working method and the scope of the proposals. We believe that the principles applied to the regeneration of the Havana harbor can be applied to the rest of the city[1]. The harbor area was also divided into sectors for a more detailed study of each zone.

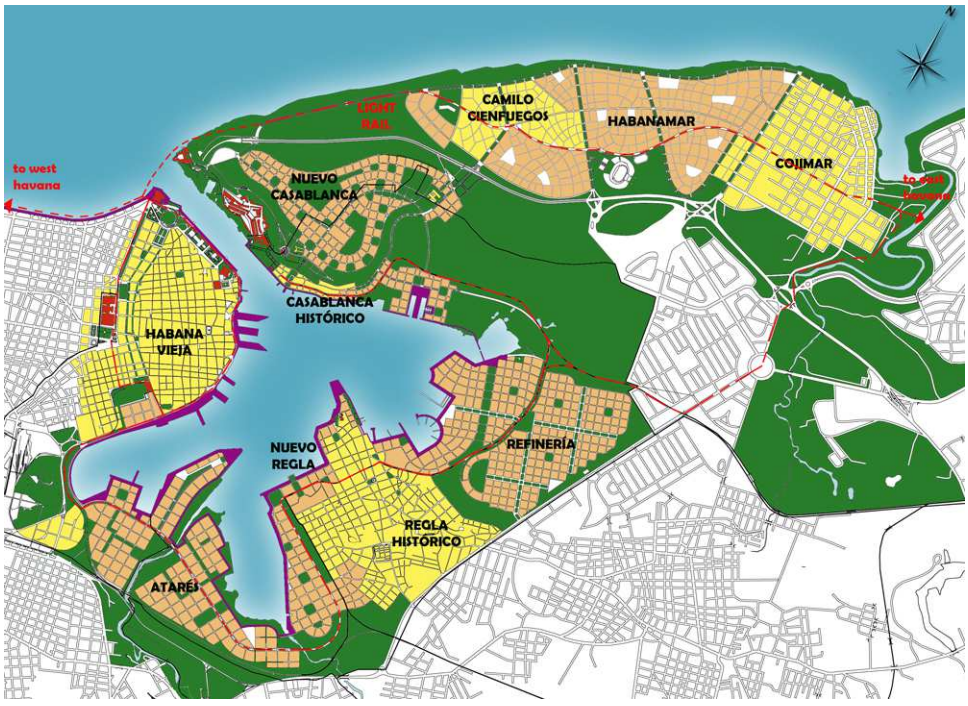


Figure 3. The Master Plan for the Harbor of Havana (© J. C. Pérez Hernández).

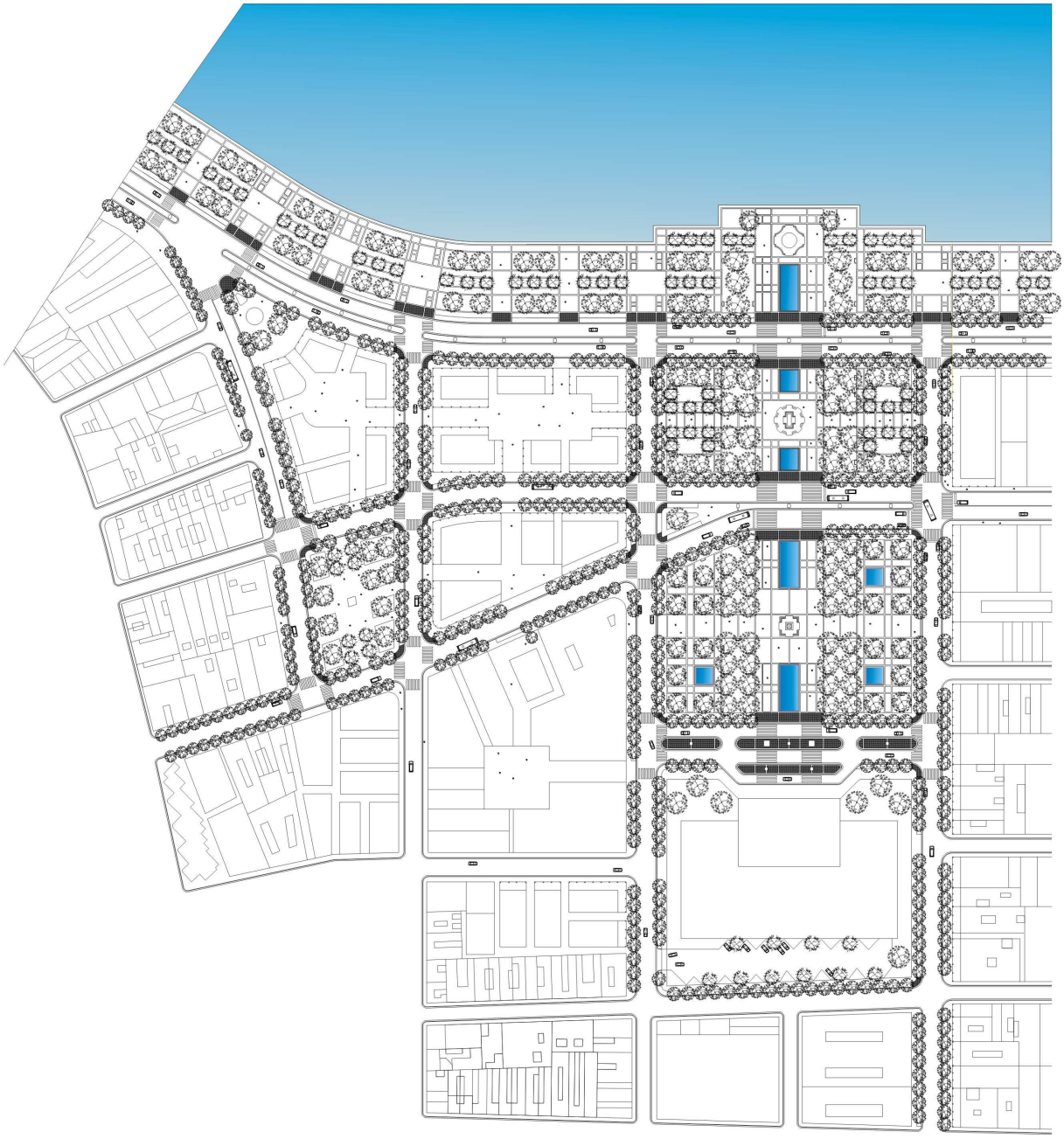
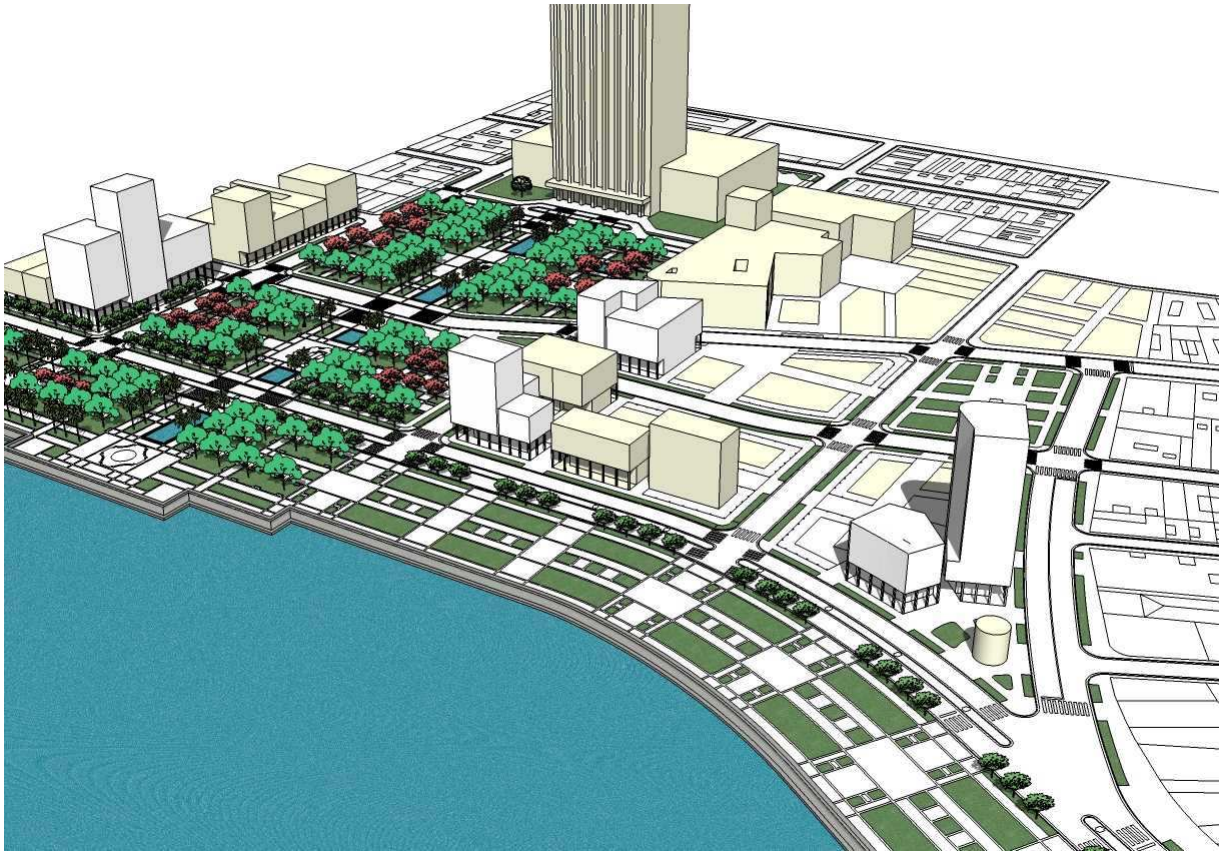


Figure 4. Proposal for the Parque Maceo.
Next page, figures 5 and 6. Detailed views of Parque Maceo's proposal.
(© J. C. Pérez Hernández).

In environmental terms the proposal involves the sanitation of the harbor area and the existing rivers. In this regard, one of the key aspects is to turn the current industrial character of the harbor into a sport and recreational one allowing at the same time for the increase of public space in its entire perimeter and the creation of new mixed use areas mostly for residential, commercial and cultural facilities as well as sports.



This principle can be applied to other areas in the city. Three international Charrettes have been held in Havana along 2007, 2008 and 2009 and they have focused on the planning of the harbor as we believe that its regeneration can serve a s a model for the rest of the city's. Two other international Charrettes have been devoted to the detailed study of two other different waterfront sectors – the East Havana (2010) and Centro Habana (2011) – adjacent to the harbor. This way the ideas of the Master Plan have been tested with the participation of the community.

The Plan also includes the creation of a new public transportation system, whose coastal stretch would run parallel to the Malecón, presently overrun by traffic, thereby freeing the ground level for pedestrians and increasing the public space along the waterfront. This strategy takes advantage of the existing topography of the reef and also helps to deal with eventual rising sea levels due to climate change by creating a buffer zone. Such zones should be outlined in order to protect the surroundings of the oldest areas of Havana from the marine aerosol of the sea.

The plan presents an ecological alternative to suburbanization by reinforcing the polycentric character of the traditional city and by increasing the amount of green spaces. To reduce sprawl, it focuses on the revitalization of the traditional commercial arteries, the *calzadas*, where community life is more vibrant.

The Master Plan emphasizes the mixed use character that is found in traditional Havana. It reinforces the identities of the different districts and the need for density balance in the traditional centers where commerce plays a key role. Urban infill encompasses the creation of two new major neighborhoods, Vistamar and Habanamar, with their own new centers and space for around half a million new dwelling units tackling housing issues. This will help increase connectivity and regional liaisons, while giving character to these zones according to their own geography, history and culture.

The Master Plan for 21st Century of Havana aspires to a more beautiful, urban and dignified Havana where people can live, work and enjoy life: a contemporary city that respects the spirit of the place, values its heritage and honors its culture.

Geothermal Heat Exchange as a basis for visioning the City of Tomorrow

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ABSTRACT

The City (of Tomorrow) is here *now* – but only *if* we transform our current urban fabrics into organic whole systems of operational performance. Geothermal exchange offers the platform for doing so.

This paper presents an overview of geothermal technology, discusses in some detail a large-scale (urban) application at Ball State University, a Midwestern campus in the U.S., and addresses the visioning of the City (of Tomorrow) as a reconceptualization of current urban fabric *as an energy-balancing system.*

Keywords: Geothermal technology, Ball State University Campus, City of Tomorrow

THE TECHNOLOGY IS HERE

Use of the earth as a thermal capacitor is not new. Geothermal technology has been operational in the marketplace for some years and many technical variations are available. The three broad categories are: 1) 'hot-rock' water/steam sourcing; 2) open-loop ground-water extraction; and 3) inert thermal exchange.

Since the first of these is geologically place-dependent and since the second is ground-water depleting and can compromise nature's filtration in the recharging of ground water, these are not favored by this author. Rather, the following discussion focuses on universally-applicable closed-loop thermal exchange.

The primary challenge to sinking and sourcing thermal energy in closed-loop systems is physical placement – whether as an *extensive* horizontal truncation of tubing in the earth (or in a body of surface water) or an *intensive* field of deeply-drilled bore holes.

Horizontal placement requires considerable land excavation (or water area) and, depending upon depth, may require glycol-treated fluids to obviate freezing; whereas vertical bore-hole placement can be positioned under other land-surface-uses such as recreational fields, athletic fields and parking lots.

In all cases, the *proportionality* of exchange-pipe spacing relative to the thermal storage capability of the earth (or water body) must be examined. Placing the runs of exchange pipe too close together can compromise the storage and extraction of thermal energy; placing them too far apart can miss an optimal use of the earth (or water body) as a capacitor. Proportionality is key.

Geothermal systems are used most often in single-building application, largely because the technology is treated as a "fix" to a "problem"… how to heat and cool a building cost effectively. Since such geothermal projects are undertaken one-at-a-time, the issues of available site acreage (extensive horizontal placement vs. intensive vertical placement), and the nature of thermal capacitance of the soil (or water) are typically the extent of issues examined. And, since these one-off projects involve single-system ownership, the financial evaluation is based on returns on investment for that owner, alone. As a result, the ability of the technology to achieve a more-leveraged optimal *systemic* performance in larger-scale (urban) application is forestalled and the more cost-effective community opportunity is sacrificed.

Nonetheless, scaling-up is readily possible. With whole-systems thinking, we can treat sectors of city fabric as a singular organism supported by geothermal energy exchange. Scaling up, however, is not in itself the issue. Rather, the breakthrough opportunity, for geothermal technology at the urban scale is its use as an energy balancing system. For those buildings that are overheating, the heat-energy extraction from the cooling function can be transferred to those other buildings in the urban fabric that might be in need of some temporary heat-energy input. This is typically the case during the swing seasons of the year in the transition from the winter-to-summer and summer-to-winter temperature régimes.

Modulating the flows of energy through transfer from one building to another as well as sourcing and sinking to the earth itself, amplifies the importance of treating the urban fabric as a singular organic system, and most importantly frees the designer to integrate multiple scales of architectural intervention:

- The manipulation of individual building location, form and (passive) envelope metabolism;

- The location and patterning of the geothermal energy sourcing and sinking (under land uses);

- The (active) behavioral adaptation of building occupants to operational system performance.

Rather than designing any one building for perfect climatic fit, the opportunity, architecturally, is to consider the community of buildings as exporters of energy. Thus the question of balancing energy flows is not tied to an optimal sizing of a single building

location, form and envelope, but rather using the factors of location, form and envelope to open the opportunity for export of excess energy. Depending upon building components used, such exporting of energy flow can occur at multiple scales, moving collected energy from the east-facing façade in the mornings for delivery to the west-facing façades in real-time, or shunting excess energy on the south façades during the day to storage – for use at night.

The location of vertical bore-hole fields can be pre-planned for placement under recreational fields, athletic fields, parking lots, selected street areas and walkways; and with careful proportioning and proper depth these can be virtually maintenance-free.

The opportunity for active participation by building occupants in the "sailing" of their building, using those operational components of the envelope that permit adjustments to daylighting, ventilation, sun-shading, and thermal energy capture and/or electrical production, can affect interactive behavior. To achieve that level of participation, however, occupants need real-time feedback (typically a computer-based dashboard system) wherein building occupants have some sense of how their day-to-day activities influence energy use. (Not unlike the driver of a car whose self-aware pressure on the gas pedal controls the real-time as opposed to "expected" miles per gallon.)

Financing of geothermal technology can benefit from larger-scale application. Evaluation requires long-term performance assessment and must include not only the return on investment resulting from annual operational cost-savings but also the avoided future cost of carbon-taxation for the community of buildings. Geothermal technology can eliminate on-site fossil-based energy conversion and by depending primarily on (Scope 2) upstream electrical supply offers the opportunity to leverage the impact on fossil-based brown-power and, most importantly, offers the strategic opportunity for the sourcing of upstream green-power from wind, solar-electric and hydro-power feeds into the grid.

THE BALL STATE UNIVERSITY CAMPUS RETROFIT

In 2009, the Ball State University Board of Trustees approved installation of a campus-wide district heating and cooling geothermal system to service all 47 buildings on campus (Figure 1). The project is being undertaken in two phases; the north energy-station with two geothermal heat pumps linked to some 1800 bore-holes will service some 20 buildings in the north half of campus and the south energy station of similar capacity, using some 2300 bore-holes will service the remaining 27 buildings. The north-half will become operational this September, and the south-half phasing will begin construction thereafter. Once the full system is complete, it will be operated as a singular network.

The opportunity to use the system in energy trading (balancing) was a serendipitous discovery. In the process of developing the project it was found that during the swing seasons of the year, the amount of cooling and heating energy being pushed onto the campus was roughly equal and with the campus-scale energy exchange system could become a building-to-building exchange and transfer opportunity.

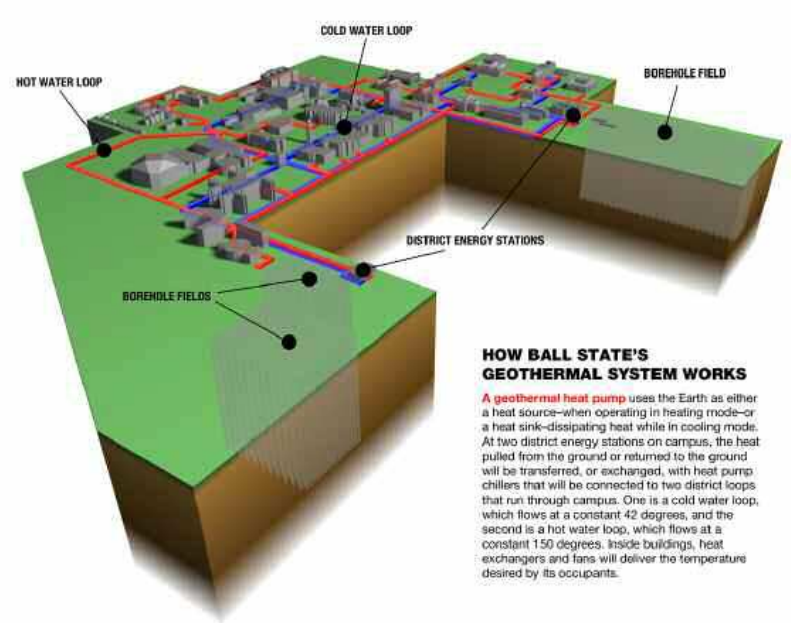


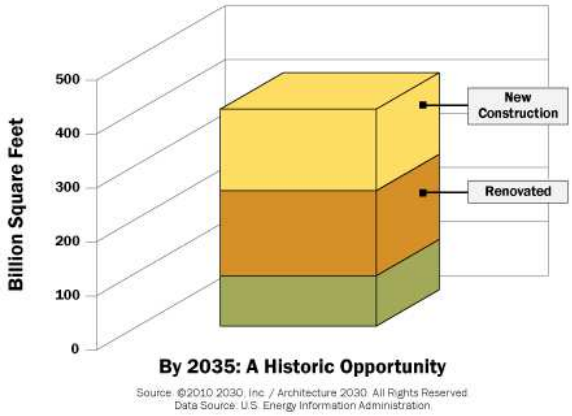
Figure 1. The Ball State University Geothermal Installation (© R. J. Koester)

Another discovery of our approach is the relative ease of retrofitting the existing 47 buildings. Those that are newer have hot-water-based air-handling exchange and hydronic systems and those that are older have relied on steam temperature régimes; *both* supportable by the geothermal district heating and cooling installation. Each retrofit is simply a matter of proportioning the face-plate area of exchange coils.

Installing this system on the Ball State campus will eliminate the combustion of fossil fuels onsite, reduce our annual CO_2 emissions by some 85,000 metric tons (roughly half of our total annual impact) and put in place the new strategic platform from which to develop further management and reduction of greenhouse gas impact. By eliminating onsite (Scope 1) emissions, we will become an all-electric campus, and can then turn our attention to the upstream (Scope 2) brown-power supply. From the beginning, we will experience reduced net annual cost of operation by eliminating the purchase of coal, and we will experience the positive upstream impact of CO_2 equivalent reduction, based on the high co-efficient of performance of the geothermal technology (wherein every Watt of electric energy purchased yields 7.7 Watts of thermal energy generation). This sets in place the opportunity for a similar multiplying effect upstream for every building-scale energy conservation move we plan to make. We also will look to the sourcing of green power on the grid as a means of leveraging further impact from the geothermal installation. Wind power, solar electric, and hydro-based electrical generation can all contribute as green power sourcing.

VISIONING OF THE CITY OF TOMORROW (TODAY)

The City of Tomorrow as a "vision" is best framed as an extension of the City of Today. The majority of our extant building stock is in fact the platform for The City of Tomorrow. We must conceptualize the transformation and evolution of that existing fabric and a substantial means to do so is to consider the geothermal implantation as the seed for reconsidering urban growth and form.



- *As of 2010, the total U.S. building stock is approximately 275 billion square feet.*
- *During normal economic times, we tear down approximately 1.75 billion square feet of buildings each year.*
- *Every year, we renovate approximately 5 billion square feet.*
- *Every year, we build new approximately 5 billion square feet.*
- *Herein lies the hope. By the year 2035, approximately three-quarters (75%) of the built environment will be either new or renovated.*
- *This transformation over the next 25 years represents a historic opportunity for the architecture and building community to avoid dangerous climate change.*

Figure 2. Upgrading existing and new Building Stock by 2030 (© R. J. Koester).

As noted in the work of Ed Mazria and his Architecture 2030 initiative, fully three-quarters of the new and existing building stock in the United States can be brought to Net-Zero-Energy performance by 2030. As noted in Figure 2, "the next 25 years represent a historic opportunity for the architecture and building community to avoid dangerous climate change". The retrofit and upgrade of existing buildings and the Zero-Net-Energy performance design of any new construction, can certainly be undertaken in a building-by-building approach. However, the argument framed with this paper is to consider instead whole districts of urban fabric as the problem space for design intervention. To the extent that we can reconceive buildings as potential producers of energy, understand them as working collectively as a set of performing entities, and to the extent we can draw in the active management by building occupants, we can arrive at the Architecture 2030 goal more easily. In that context then, the

use of geothermal technology offers great promise. The notion of a geothermal ground source heat pump installation at the district scale provides a kind of bank account by which to achieve day-to-day, seasonal, and annual balancing of flows within any given building and from building-to-building.

DISTRICT-SCALE IMPLANTATIONS OF NEW CONSTRUCTION

This concept of district-scale, community design and especially implantation of new construction is most imaginatively captured in the work of The Center for Sustainable Cities at the University of Kentucky. In their proposal for the Westbahnhof Project in Vienna, the full urban implantation compound could readily benefit from the strategy of singular geothermal district heating and cooling. The particular architecture of the compound, which treats the "city (sector) as a hill" of course benefits from the "mounding" of program massing to minimize climate envelope exposure and maximize spatial character of the urban implantation. Mimicking the spatial experience of the Italian hill town, the project benefits from numerous shared resourcing including pedestrian circulations aggregated separately from vehicular circulation, opportunities for maximized energy production from overall orientation of the linear scheme and localized inflection of climate interface at the scale of dwelling units or unit groups; while underneath the outer layer of this residential fabric, there can exist larger scale community space including factory production, retail and warehousing.

While the Westbahnhof Project reflect tremendous insight and vision, it amplifies the notion of district scale energy management as a point of entry in the district-scale retrofit of existing building stock and the district-scale implantation of new construction. Certainly in support of the argument presented by Ed Mazria, and as reflective of the experience of this 47 building complex at Ball State University energy balancing is the fundamental key to successful design-for-sustainability and reduction of climate disruption.

Figure 3. Aerial view from the southeast, overlooking the Shoenbrun Palace (© R. J. Koester)

SUMMARY AND CONCLUSIONS

Geothermal technology is not new, its conceptual application, however, can be. Using the power of successive scalar aggregation through ground-source-heat-pump district heating and cooling, geothermal can unleash new opportunities for reconceptualizing the location, form and surface features of our urban fabric, the role of geothermal as an energy balancing/trading tool, and the influence of these changes on building occupant understanding of the city as an organic system.

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Book reviews

THEOLOGY AND ARCHITECTURE AT THE TIME OF THE FALL OF GODS

Heidemarie Seblatnig (ed.), *Hetzendorf und der Ikonoklasmus in der zweiten Hälfte des 20. Jahrunderts*. Vienna: Facultas Verlag, 2010

review by Stefano Serafini

Yet at first sight, one may disagree with book's title harshness («Iconoclasm in the second half of the 20th Century»), reading through the nine essays composing the volume, could result in a change of mind.

A polemics among traditional and progressive Catholics lies for sure under this work, but due to presented facts, data, and analysis, it results worth of reading also for secular Architects, Historians and Sociologists.

The phenomenon of a few men's will of transforming a neo-Roman Catholic parish church, into a modernistic and quite aniconic building, in Austria, during the 50s, represents an interesting document about European culture after the Second World War. Authors show and explain from different points of view the ideological reasons that lead to what, today, looks even odd, and really not too far away from the definition of "modern iconoclasm" offered by Authors.

The Rosenkranzkirche in Hetzendorf, Vienna (Church of the Rosary, 1909, architects Hubert Gangl and Eugen Ritter von Felgel) is an exemplar of Nordic Catholic neo-baroque, with a special character, that made it unique among all Vienna's churches: architects worked together with the sculptor Franz Zelezny, who designed the interiors, including furniture, the chandelier, and the wooden relief panels of the stations of the cross, with the aim of producing an organic art work, even at the scale of the last detail. Work resulted in a imposing, pleasant, and harmonic building, with a strong traditional identity, but at the same time an original feature. A model of the project is preserved in the Museum of Vienna, while the Wien Technichische Universität has produced a virtual rendering of the original interior in 2008.

The editor tells us how two relevant religious figures, such as Msgr. Otto Mauer, and Fr. Joseph Ernst Mayer, firmly struggled for the transformation of the church, going even further, by finally destroying most of the furniture, statues, panels, and melting the chandelier. According to H. Seblatnig, they did it for the sake of the liturgical reform introduced by the Council Vatican II, while D. G. Stroik, in his contribution, shows as aniconism to which they referred as an ideal, belonged to the very root of Modernism in architecture. It's noteworthy that both protagonists of this story, were members of the ultramodern art association "Bund Neuland", influenced by the Viennese Actionism, and behaved as patrons of the arts. Not by chance, card. Franz König instituted the "Otto Mayer price" for modern art in 1981.

Restructuration was carried on by architects Friedrich Achbeitner and Johann George Gsteu. «Sacred architecture become the experimental area of young architects supported by influential representatives of the Church who used the interest of the young architects in experiments to further their own schemes of liturgical restructuring within the Church» (p. 177).

Thus, a mutual influence among art innovation and liturgical reform worked in Hetzendorf, with the participation of high rank intellectuals and Church officers, and it cannot be recorded as a mere accident. For sure, it is an example of an elitist operation. It's noteworthy that not only actors didn't care about users' opinion, but in fact they acted against the will of parishioners, the majority of which did not like such a transformation. People were considered too "ignorant" to have a say about what was going on with their church. At the very end they were cajoled (see Fr. Meyers' speeches about the future "beauty" of the church) or fooled (the destruction work carried on at night), in order to be "rightly" driven. «The events around the Rosary church in Vienna-Hetzendorf show the intentions of leading representatives of the Church in Austria already in the year 1957, i.e. five years before the Council. Hetzendorf was a pilot project that should give an answer to the question: "To what degree can the faithful be excluded from the restructuring of sacred architecture and thus of the liturgy? What can be enforced against the will of the faithful under the headline of pretended 'democratization'?"».

A larger reflection about the health condition of both Church and art, is carried on by Walter Brandmüller, who says that both «Church and art must overcome this crisis of identity they have both come in because of the ideological development of Modernity» (p. 216).

Gherard Schuder recollects the origins of such a crisis in the thought of Martin Luther, seen as an expression of modern bourgeoisie, and refers to the very concept of incarnation as the real target of iconoclasm. Actually, most of the catholic supporters of the new liturgical aesthetics, declared a sympathy for Protestantism, and revealed an attraction for a non-analogical concept of God's uniqueness, quite similar to that professed by Arius during the 4th century. The very Le Corbusier – atheist son of a Calvinist pastor – took his name of art from a Cathar, who had escaped the crusade against his sect. Puritanism and war against ornament seemed to form a natural alliance.

The same concept has been well explained by Ciro Lomonte in his contribution, fundamentally blaming the ignorance of certain members of the Catholic Church, too enthusiastically following the "zero option" of modern art, without recognizing the theological roots of such a position. On the other side, Lomonte suggests to react not by refusing the modern as such and, in doing so, "zeroing the zeroing". On the contrary, contemporary Church should find the way to a new figurativism, with modern ornament and proportion, in order to be able again to exhibit the meaning of the incarnated *logos*.

The book offers a double (yet weak, sometimes) translation of each contribution, so that it can be read in German, English, and Italian.

LIFE'S MATHEMATICS FOR LIVING SPACES

Nikos Salingaros, *Twelve Lectures On Architecture. Algorithmic Sustainable Design*. Solingen: Umbau Verlag, 2011

review by Stefano Serafini

Can architecture and urbanism be formulated as applications of computations? Yes, according to the well-known urban thinker and mathematician Nikos Salingaros. And they actually should! Salingaros offers design practitioners, with a very sketchy and intriguing way, a method of applying cutting-edge mathematical techniques to architectural and urban design.

Despite of the novelty of this approach (just few of these topics are actually taught in architecture schools), his position belongs to a very ancient tradition. One can just think to the masons of Middle-age cathedrals, and their mathematical insights bringing to light amazing structures. They considered and managed each step in the design process, as a computation. And this brought to that gorgeous effect of continuity among scales in their buildings, quite always resulting in harmonious cascades of fractals.

Salingaros explains how we can use geometrical constructs such as Cellular Automata, recursive growth, the Fibonacci sequence, fractals, universal scaling, etc., in design work today, and why this can produce very effective and pleasant buildings. His effort aims not just at reviewing a mathematics set for architects, but at presenting one useful design tool, a full computational methodology, and a fundamental reason for new structural rules.

The most interesting part of this work is that these rules produce new forms belonging to the great set of natural shapes, instinctive architecture, and classic masterpieces of all times. This offers great insights about architecture itself, and about the relationship among nature and culture. Salingaros' explications of why such algorithms are successful, sound convincing, and introduce the reader to biophilia, environmental psychology, and a deep critics to traditional aesthetics.

THE EIDETIC KERNEL OF THE CONCEPT OF FORM

Jean Petitot, in collaboration with René Doursat (ed.), *Cognitive Morphodynamics. Dynamical Morphological Models of Constituency in Perception and Syntax*. Berlin: Peter Lang, 2011

review by Stefano Serafini

Jean Petitot (jean.petitot@polytechnique.edu), philosopher, mathematician, semiologist, and expert of neurocognitive modeling, is the current director of the *Complex Systems Institute*, Paris, and teaches at the *École des Hautes Études en Sciences Sociales* (EHEES), Paris.

Disciple of the great and revolutionary mathematician René Thom, he's instantiating his master's theories, especially semiophysics, in the fields of linguistics and cognitive sciences areas since several years. This crucial work offers a general overview of his researches, thus stressing the dramatic relevance of the concept of form.

What has this to do with urbanism and architecture? Nothing at all, apparently, especially for those considering design just a matter of aesthetics.

In reality, as city and buildings shapes result in "informing" (in the deeper sense of the word) human life, this book has a high value for all professionals who like to reflect on the real matter of their own activity.

This is not a work aimed at architects, of course, a fact one can acknowledge by simply checking the architect-not-friendly writing style. The wide range of Author's expertise is reflected in the way he manages linguistics, epistemology, logics, mathematics, computer and cognitive sciences, and related terms and symbols, making non-specialists unease sometimes.

Just to have an idea: its declared goal is about giving a mathematical foundation of Cognitive Grammar, by using René Thom's morphodynamics.

Don't be scared. Cognitive Grammar is a milestone of cognitive linguistics, founded by Ronald W. Langacker (*Foundations of Cognitive Grammar*, Volume 1, *Theoretical Prerequisites*, 1987; Volume 2, *Descriptive Application*, 1991. Stanford: Stanford University Press). It is largely based on findings of Gestalt psychology, especially applied to visual perception. According to this approach, language is eventually built by basic conventional formal "bricks", related to both semantics and phonology. Grammar combines these "bricks" under strict rules, so generating phrases, that thus have semantic and phonological structure. The semantic aspects are modeled as image schemas rather than propositions, but because of the structural relation with phonology, images and speeches go always together, as different facets of the same basic structure. According to Langacker, linguistic structures are thus rooted into cognitive processes. We speak as we are, and the range of linguistic conventions, at the very end, is constrained to a finite set, by what we could dare to call "reality". Discussions are open about what this "reality" in fact is. Recent promising advancements in neurolinguistics, for example, are pointing out the study of the bridge between linguistics and neurophysiology (see M. Piattelli-Palmarini and J. Uriagereka, «Still a bridge too far? Biolinguistic questions for grounding language on brains», *Physics of Life Reviews* 5 (2008) 207–224).

Anyway, that's the path that brought Petitot to investigate morphological structures of perception into Gestalt-like and abstract proto-linguistic schemes, i.e. semi-raw material for producing superior linguistic operations. He shows us how there exist deep, syntactic and semantic structures of language, that are grounded in perception and action.

On the other side, Thom's morphodynamics is the study of forms (both natural and artificial), whatever their underlying physical substrate may be, and of their mathematical norms, from the point of view of semiophysics (that is, a physics of semantics). As Petitot states: «Syntactic structures can be treated as Gestalts and can be morphodynamically modeled» (p. 203).

At this point we could question if referring to architecture (and urbanism) as "a language", may be something more than a metaphor. Indeed it is. There exist a semantic of architecture (e.g. its relation to residential function, or environment), and a way of instantiating such a semantics, that is a syntax (style, use and combination of materials and shapes, etc.).

The problem is that this natural vision of architecture as language, has been pulled into a conventionalist idea of language – where all that counts is the *abstract sign*, without any reference but to other signs.

What Petitot's work has therefore to say to architecture is that: A) syntax cannot be a totally free and dissociated "creation", apart from its semantic; B) both semantic and syntax have a third meta-level to which both of them refer; C) this meta-level has its own consistency that needs to be known and studied; D) syntax, semantic, and the meta-level, have a structural coherence in the natural word, that makes them coincide in a dynamical way.

«In morphodynamics, the conceptual contents of mental states are no longer identified with symbols. Their meaning is embodied in the cognitive process itself (…) Information processing is therefore thought of not as an implemented symbolic processing but *as a dynamical process*» (p. 203).

Such a dynamical process has a form. «(…) mathematically, physical models are in general of a geometric-dynamical nature. Every physics is a geometrodynamics. Therefore, if we are able to extract syntactic structures by abstracting invariants from such a geometrodynamics we become able to understand the link between an ideal formal "syntacticity" and the underlying (neuro)physics. It is in that sense that geometry and dynamics are key to formal syntax» (p. 276).

In fact, according to J. Fodor and Z. Pylyshin, the goal is achieving that «"geometrical whole, where the geometrical relations are themselves semantically significant", and which constitute the geometrical basis of constituent-structures» (p. 275).

A sentence, that seems a program for an architecture renaissance.

News and events

OPEN PISM. SHORT COURSE IN SUSTAINABLE PARTICIPATORY DESIGN AND BIOURBANISM: JANUARY 15TH – APRIL 15TH 2012

Challenging design studios, seminars and lectures, offer participants a new theoretical approach to urban environment design, based on biophilic and morphogenetic theories. The course, delivered via the internet
(videoconference), is the first to provide a basic education in biourbanism.

Ten intensive lectures and two electives workshops will be held during 2012. Topics: Theory and context in the XX century; Biourbanism, basic skills; Participatory design: Tools and methods; Examples and best practices.

Info: http://www.pism.uniroma3.it/wp-content/uploads/2011/07/openpism2012_eng.pdf

HAVANA URBAN DESIGN CHARRETTE: 19-25 FEBRUARY 19TH-25TH 2012

INTBAU Cuba and CEU Cuba, and INTBAU Scandinavia invite you to the 2011 Havana International Urban Design Charrette. Join Cuban experts and local communities to develop proposals for the regeneration and development of the waterfront area of Centro Habana.

The charrette will fit both educational and professional purposes, and will give participants an introduction to the history of Havana's cultural heritage through close contact with its traditions, architecture and urbanism. The charrette seeks the participation of individuals who share a respectful attitude to new interventions in historical contexts, and who value the creation of places humans can live in, work in, and enjoy.

Info: http://doityourself.no/intbau/?p=327.

NEUROERGONOMICS AND URBAN DESIGN, ITALY: JULY 14TH-22ND 2012

International Society of Biourbanism, University of Derby, UK, and Università Roma Tre, Italy, invite you to the *Summer School on Neuroergonomics and Urban Design. Biourbanism for a Human-Centered Sustainability and Effectiveness*.

An authentic sustainable design must deal with energy- and environment-saving technical solutions, but also with functional and restorative connection to human neurophysiologic system. Psychology and medicine show how space design can nurture or damage our wellbeing. A scientific knowledge, both theoretical and practical, of how human

neurophysiology reacts to the organization and the shapes of space, is the first step for producing a really sustainable new design for the 21st century.

This residential course is aimed at giving participants (architects, designers, engineers, psychologists, social scientists, and policy makers) a unique competence in a new field of practice and research, with relevant professional opportunities.

Course will be held at Artena (Rome), Italy, a beautiful and picturesque little town dating back to 13th century, placed on a hill of the Lepini Mountains at 420 mt above the sea level, 40 km South far from Rome. This is the perfect place to visit the fascinating surrounding area, with such historical towns as Palestrina, Segni, Anagni, Sermoneta and Norma, and many gorgeous natural beauties. It is located at just 40 minutes from Rome (by both train or car), and few minutes from the amusement park Rainbow Magicland, and the Fashion District Outlet of Valmontone. Students will be hosted in the historical village centre, enjoying the typical local architecture and… mules, as these nice animals are used in Artena still today!

Info: http://www.biourbanism.org/neuroergonomics/.

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