The Biophilic Healing Index (BHI) as a professional tool for indoors and outdoors active living design

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Abstract

The Biophilic Healing Index is a professional tool for architects, urban designers, and planners in process of validation and is advocated by the author of this paper and several international colleagues who share the same ideas and network interactions. For several years, the author had several discussions with international caliber experts about the applications of specific theories in design, architecture, urban design, and planning practices. She shared research with her undergraduate and postgraduate students through various modules' delivery. Recent scholarly activity included studies and ideas for transforming Derby into a livable city by connecting with local communities and supporting mediation between them and local policymakers.

The students enrolled in the Research and Urban Design Module for the BA(Hons) Interior and Venue Design Programme had the opportunity to produce and exhibit proposed changes to the urban fabric in key areas of the city on several occasions. In 2021-2022, the author and her students developed ideas for the integration of the University campus to allow for the development of active living urban spaces for students, staff, and nearby residents. Being facilitated by their tutor, the students met with local communities in forums to carry out surveys. Their findings from the interactions with locals helped and inspired them to select specific sets of patterns of biophilia. Existing percentages of patterns were measured by using the Biophilic Healing Index (BHI); these measurements allow designers to understand where they should be able to increase specific values to secure the health and wellbeing of all citizens. By using the BHI as a tool, new proposals for improvement of the urban space can have a positive impact on people's health and wellbeing. Information on patterns to be specified and improved indicated that human behaviours could change dramatically, too. Therefore, the proposed urban design solutions were tagged with specific UN Sustainable Development Goals (SDGs) to allow for vital reviews of the city's master plan by setting priorities of intervention for the local policymakers.

Biophilia has the power to change human behaviours, when designers, architects, communities, and policymakers work together to transform cities into livable and resilient. "Livability relates to urban design and planning, elements which can influence a city's social mobility and financial prosperity. A livable neighbourhood can be compact, sustainable, diverse, green, healthy, accessible" (Tracada and Al-Wali 2020, p36), and above all active and resilient. Thus, it is important to get communities directly involved in active decisions and policy-making. The author argues that policymakers should provide means and support for specific actions, not just promises. The latest events from Covid-19 taught us that the built environment and the urban spaces in which we live should guarantee all citizens' quality of life. In this chapter, we can show our unique approach to using the Biophilic Healing Index as a tool to evaluate the existing urban space and promote new developments by considering active healthy living for all. We explain how we have managed to connect with scholars internationally, and how we transferred our experiences to learning and teaching. The author selected design proposals related to one specific area of our University campus in which the public space is in desperate need of transformation to become healthier and more inclusive simultaneously.

Keywords: Biophilic Healing Index (BHI); Healthy placemaking; Biourbanism; Sustainable Development Goals; Active City Living

1. Introduction-Background

For several years, the author had discussions with internationally recognised experts about applications of theories based on the Laws of Nature, especially Constructal Law. Her scholarship activities were triggered by a personal interest in the design of a healthy built environment and urban space since her studies pursued in architecture. She engaged in live projects that were part of her architectural education. So, she developed active and independent research interests in inclusivity in design and placemaking for thriving, healthy, and happy communities.

Her studies in architecture and urbanism led to several important publications and presentations. In 2015, these long-standing activities were completed by her PhD by Published Works thesis and critical reflection based upon selected

publications predominantly related to her delivery of architectural design in further and higher education. (Tracada 2015). The author and her colleagues intend to provide the new generation of designers and architects with new skills and tools to develop a better-built environment and public space for a healthier and happier future.

The author continued to create strong links and networks with professionals from many countries for several years. In 2010, Dr Antonio Caperna, President of the International Society of Biourbanism (ISB), asked the author to join the International Society of Biourbanism and become a member of their Scientific Committee. As an Editor-in-Chief, she managed to coordinate and support a series of special issues of the Journal of Biourbanism (2011-2014).

The author's approach to learning and teaching is to share research with her undergraduate and postgraduate students through various modules' delivery. Recent scholarly activity included studies and ideas for transforming Derby into a livable city by running meetings with local communities to support mediation between them, the local policymakers, and other organisations, such as charities and community cultural committees (Tracada 2017).

Since 2016 and in collaboration with Graham Cairns, then Chair of Architecture_Media_Politics_Society (AMPS), the author co-organised the Conference 'Cities, Communities and Homes: Is the Urban Future Livable?' held at the University of Derby on 22-23 June 2017. The author edited the Conference Proceedings (two volumes) and wrote a chapter concerning proposed ideas by student projects for the Normanton Peartree suburban area (Tracada 2017). Being facilitated by their tutor, the students who had enrolled in Module Project Research and Urban Design had the opportunity to spend time in forums with the local communities. Subsequently, the students have learned to apply and combine primary research findings with specific sets of selected biophilic patterns. The students also presented and exhibited their projects during the AMPS conference. Since 2017, further education and research activities have taken place, always focusing on applications of specific biophilic patterns (according to required solutions) to improve conditions in the built environment and urban areas susceptible to regeneration processes. In the following years (and still ongoing), students tagged their proposed solutions and projects with specific Sustainable Development Goals (SDGs) by using computations of biophilia to recommend indicators for priorities of necessary interventions to fulfill the SDGs. The students learned about Voluntary Review Plans (VPRs); they analysed and evaluated case studies included in the publication 'A Territorial Approach to SDGs' OECD Urban policy reviews (OECD 2020 & 2022).

2. Using the Biophilic Healing Index to test inclusive and healthy places and spaces

Although she came across Christopher Alexander theories and practices as a student in architecture in the 1970s (Alexander et al. 1977), the author's legacy with Biourbanism and Biophilia began in 2010 when she started interaction and discussions with other colleagues/ devotees of Christopher Alexander Pattern Language (Battie and Xie 1999, Battie and Longley 1994). During special ISB summer schools in abandoned villages and hill towns near Rome, the author was invited to give a series of special lectures and delivered workshops to international research scholars. Thereafter, urban theories and practices were further studied, and peer-reviewed outputs were presented at conferences and seminars. The author has been mainly focusing on and exploring human communications in the urban historical and active networks (Tracada 2013a), named "grids of energetic pathlines"; she is constantly interested in the exploration of human behaviours and communications regulated by the Laws of Nature, such as fractal geometries, tree architecture expansion of urban space, etc. (Bejan and Lorente 2013). All these research activities helped her understand the importance of the use of the Biophilic Healing Index (BHI) for the design of future healthier and livable cities.

Biophilia has the power to change human behaviours, when designers, architects, communities, and policymakers work together to transform cities into livable and resilient. In her latest presentation online for British Science Week, the author reiterated that:

> Livability relates to urban design and planning, elements that can influence a city's social mobility and financial prosperity. A livable neighbourhood can be compact, sustainable, diverse, green, healthy, accessible, and above all resilient. (Tracada 2022, Tracada 2018, Tracada 2017)

Hence, it is important to get communities directly involved in active decisions and policy making. This can be achieved by promoting SDGs through Voluntary Review Plans with full stakeholder engagement (OECD 2020). The author argues that policymakers should provide means and support for specific actions, not just promises. The latest

events from Covid-19 have taught us that the built environment and the urban spaces in which we live should guarantee all citizens' quality of life. In several areas in the proximity of Derby City Centre, for example, data published by health authorities showed that death rates were extremely high in areas where access to public green spaces was restricted. However, all these areas contain historical green parks which were closed to the public for almost a year and a half. Instead, streets were clogged by car traffic, and backyards were filled with unwanted items and garbage.

Basis to argue and ask for immediate acts (Tracada 2022) (not only promises) should be the World Health Organisation statement:

> The health of a city's people is strongly determined by physical, social, economic, political and cultural factors in the urban environment, including the processes of social aggregation, migration, modernisation and industrialisation, and the circumstances of urban living. (WHO 1991)

The author argued that the impact of urban processes on human health is the sum of effects from a range of factors; this means that:

> … scholars and citizens should make policymakers understand that cities need immediate attention by balancing built and urban space in a way that ensures that the health and safety of citizens are always safeguarded. (Tracada 2022).

Without any exemption:

> Human behaviours must change if we wish to save the planet. Ill Earth means ill life on it. All of us should be aware of our responsibilities. (Tracada 2022).

And here is where Biophilia could have a real impact. After the AMPS Conference, the author and her students in Module Project Research and Urban Design were invited to surveys and discussions with the local communities and housing associations in the Normanton Peartree and Arboretum wards of Derby. Materials from these activities were collected and the author started drafting a manuscript under the provisional title of *Smart City Living – Derby*. Due to the election changes in the wards and the restrictions of Covid-19 imposed, education and research activities were limited and stopped for a couple of years.

The research activities resumed this last spring with the introduction of a new brief for the students in Module Project Research and Urban Design. Once again, the students were taught about Biophilia principles and practices and the need to reintroduce and reinforce vigorous participatory activities between education institutions and local communities. The participation of the public has been now recognised by Derby City Council by asking citizens to express their opinion on *Towards a New Vision for Derby City Centre: Ambition – 2022* (derby.gov.uk 2022). In this new vision document, we can see a map that includes only the core of the city. Only few arrows pointing outwards to the suburbs and the University campus demonstrate that more axes could reach those areas. There is no indication on how the developments related to the city centre, such as those to tackle the climate change or regenerate the green and blue infrastructure could have an impact on the renewal of the suburban areas as a result. We also find a city centre to be enclosed by a ring road system of heavy car traffic. Again, this vision contrasts to what the author has been teaching her students for several years. In 2018, at the University of Derby blog she had declared that a *livable city* should:

- Protect the history, neighbourhoods, and the environment.
- Provide accessibility and connections to neighbourhoods.
- Appreciate local products and support and invest in people.
- Be affordable, proactive, and walkable, and plan for the future. (Tracada 2018)

3. Biourbanism and Pattern Language brought together in the Biophilic Healing Index

According to the author and her students at levels 6, 7, and 8 in Higher Education, Biophilic Urban Design should be delivered as the art and discipline of making a healthy city for healthy citizens. Students and their teacher have been convinced that Biourbanism demonstrates and teaches how we can always deal with cities by acting as responsible and responsive designers and inhabitants, whatever the conditions and restrictions could be. New practices in the design of buildings and cities are now including Neuroergonomics at various stages of design and the monitoring of the impact that this discipline has on humans (Caperna et al. 2013). Both co-authors of various papers on Biourbanism, Antonio Caperna and the author of this paper, agree that human neurophysiology reacts to the organisation and the

forms of space; this is the first step to producing an undeniably sustainable new design for the 21st century (Tracada and Caperna 2013b).

Biourbanism also combines technical aspects with the promotion of social sustainability and human wellbeing. Scientists like Adrian Bejan affirm that "design is a universal phenomenon in nature… Design unites the animate with the inanimate" (Bejan and Lorente 2013) Thus, free flow forms and movements can happen naturally under the Laws of Physics, and especially when we discover urban sprawl following rules of fractal and self-organised expansion (Batty and Xie, 1999).

In the official site of the International Society of Biourbanism, we find the definition prepared by the Biourbanism Task Force:

> Biourbanism focuses on the urban organism, considering it as a hypercomplex system, according to its internal and external dynamics and their mutual interactions… Biourbanism recognizes *optimal forms* defined at different scales (from the purely physiological up to the ecological levels) which, through morphogenetic processes, guarantee *optimum systemic efficiency* and *the quality of life* of the inhabitants. A design that does not follow these laws produces anti-natural, hostile environments, which do not fit into an individual's evolution and thus fail to enhance life in any way. (ISB, www.biourbanism.org)

Ongoing research and findings on Biourbanism's impact on humans (Salingaros 2005, 2019 and 2020; Tracada and Caperna 2013b) confirm that the main principles to be followed in planning and designing cities should be summarised as follows:

- Fractal geometry connections in the urban web should be visible, and unconsciously guide the people to interact in a city.
- Mental connections and connections among urban elements should show analogy in the process to give rise to a city or piece of the urban landscape.
- Deeper the possession of geometrical information from the surroundings is, the deeper the connection of the human mind with the environment.
- Natural scaling hierarchies should organise spaces for the people; only this kind of hierarchical city growth could have a positive impact on the health and wellbeing of the citizens.

Therefore, the main objectives for the scholars who analyse the urban fabric in Biourbanism should focus on how cities could become successful (Tracada and Caperna 2013b). Cities should be studied in relation to their historical growth depending on their healthy substructure, components, and forms created by the humans. The theoretical underpinning of new masterplans for future cities should be the outcome of rigorous research to discover what we consider as urban and architectural phenomena. These phenomena are the underlying principles of the natural expansion of cities worldwide for so long. According to the author and her colleagues, a living city depends on the explosion and action of an enormous system of pathlines and people connections (Tracada 2013a; Tracada and Caperna, 2013b).

The computing of the Biophilic Healing Index was promoted as such for the first time by Nikos A. Salingaros back in 2015 (Salingaros 2015). However, during the Biourbanism summer schools, Salingaros and several authors and architects had the opportunity to disseminate their theories in such a way that local communities were able to understand them and engage fully with them. A first fine example was the Artena project, during which Salingaros suggested a simplified Biophilic Index, based upon Christopher Alexander Pattern Language. The order of those patterns was consequently explored in lectures and workshops delivered by the author of this chapter in collaboration with Antonio Caperna during short courses/summer schools, and international conferences. Several publications referring to urban fabric developments based upon human dynamics and dimensions followed these activities; they activated further discussions amongst professionals, educators, and students.

Biourbanism embraces biophilia principles and integrates activities of regeneration of urban areas in the status of abandonment and decline. Healthy principles for designing the "Built World" have been promoted by all scholars in Biourbanism aiming at the realisation of Healing Environments. Thus, Biourbanism has been established as multidisciplinary cooperation by promoting Neuroergonomics in Design (Serafini et al. 2013). Human sensory

systems are also promoted and developed by Biourbanism applied research and education projects; they have "evolved to respond to natural geometries of fractals, colours, scaling, symmetries." (Tracada 2013a). These systems are fine-tuned to detect pathologies of our body, signed by departure from natural geometries.

> Human beings require contact with the geometry of the biological structure, and social and mental health deteriorates in nature-less surroundings. (Serafini et al. 2013).

The author also adds and affirms that:

> Paths are nothing else than lines defined by geometrical conventions … considered as indexical elements; they are strictly controlled by human performance inside both natural and artificial or built environment… Every single person can be an artist or performer capable to orchestrate a cosmic movement of pathlines exploding into cosmic geometries penetrating nature and creating artifacts; this is the perpetual way of creating three-dimensional forms in harmony with human deeds or activities or actions. (Tracada 2008, Caperna et al. 2013, Serafini et al. 2013)

During their collaboration in research, Antonio Caperna, Stefano Serafini, and the author interacted with other disciplines, too. They affirmed that neuroergonomics lead to neuroesthetics in design; the latter is an attempt to combine neurological research with aesthetics by investigating the experience of beauty and appreciation of art on the level of brain functions and mental states.

> Neuroesthetics uses the techniques of neuroscience to explain and understand the aesthetic experiences at the neurological level. This topic attracts scholars from many disciplines including neuroscientists, art historians, artists, and psychologists. (Caperna et al. 2013).

The author and her colleagues came across theories and scientific output, such as *Motion, emotion, and empathy in esthetic experience* by Freedberg and Gallese who offer an interesting perspective on possible connections between neuron systems and artistic experiences:

> … a crucial element of esthetic response consists of the activation of embodied mechanisms encompassing the simulation of actions, emotions, and corporeal sensation, and … these mechanisms are universal (Freedberg and Gallese 2007, 197)

Since the author commenced teaching activities several years ago in various modules, she began to refer to all the above theories and practices, especially to Christopher Alexander patterns and codes; she explored historical context related to the genesis and expansion of cities to inspire student studio projects and dissertations.

> Christopher Alexander (architect and urban designer) talks about patterns/codes and visual language and says that designers and architects should not only be able to write and read a language, but also be able to develop it further by understanding every feature of it and by giving it new meaning according to their own identity. (Tracada 2006, 44)

And:

> Spaces are created by geometries and space for the artists becomes their real obsession. Artists, designers, and architects have been always fascinated by geometries generated by pathlines' mystical forcefulness able to create primordial shapes, cells and complex forms; form comes to the real world when a line moves along a creative performing process. (Tracada 2008; Tracada and Caperna 2012, Caperna et al. 2013)

The fascination with geometries culminates in maps of pathlines of human communication created by the so-called fractal coupling forces. Batty and Longley (1994), and Salingaros (2005) argue that traditional urban geometry is characterised by fractal interfaces. Christopher Alexander (1977) also affirms that natural growth in urban sprawl becomes evident in fractal geometrical systems. Salingaros (1999) affirms that the fractal cities are made of symmetries and patterns of fabric influencing human wellbeing:

> Plans, patterns, symmetry, axes, are only of secondary importance relative to the fundamental processes that generate urban space. This lends support for the irregularity of successful urban spaces. (Salingaros 1999)

According to Nikos Salingaros (2006 & 2008), the wellbeing of a city inhabitants can be proved by theoretical and mathematical considerations and models based on Thermodynamics. During a guest lecture in February 2021, and by discussing these models with the author's students, Salingaros elucidated on the architectural life of the built environment and the randomness of the fractal cities; he referred to simple formulas, such as the ones shown below:

> Architectural **L**ife = **T**emperature times **H**armony
>
> **L = TH**
>
> Where:
>
> Architectural Temperature = **T**
>
> Architectural Harmony = **H**
>
> Architectural Life = **L**
>
> And:
>
> Architectural Complexity = **C**
>
> Architectural **C**omplexity = **T**emperature times **D**isorder
>
> **C** = **T** (10-**H**) = **Randomness**
>
> Thus, random, and complex fractality boundaries of cities define new expansions and urban healthy fabric.
>
> (Salingaros 2006 & 2008; Tracada 2014)

Therefore, urban science and theories of human behaviours in the built and non-built environments encourage the organisation of spaces and people's lives according to specific patterns measured by Thermodynamics and Laws of Nature. Caperna and the author understand that:

> The human mind establishes a deep connection with the environment by possessing geometrical information from its surroundings. People recognise what looks and feels natural by its scaling hierarchy and react accordingly. The mathematical qualities of meaningful environments are those that manifest themselves in fractal subdivisions (an inverse-power distribution of sizes). (Tracada and Caperna, 2013b).

All the items and theories discussed above led to the latest tool that was already proposed by Salingaros (2019 and 2020) and the author of this chapter to be used as a professional tool to measure ten (10) selected patterns of biophilia; this means to support professionals in their practices to intervene and improve indoors and outdoors spaces, and also help people to maintain good health and wellbeing (to be active and happy at all times). The ten components/patterns of the Biophilic Healing Index (BHI) (see also Appendix A.) are: sunlight/daylight; colour; gravity; fractals; curves; detail; water; life; representation-of-nature; organised complexity.

Appendix A contains a document which was disseminated to the author's students on the Blackboard module pages for the Independent Study module a few days before Salingaros' online annual lecture in February 2021. Practically this document synthesised both Salingaros and the author's thoughts about healing spaces (a healthy built environment by design); it offered instructions on how to calculate percentages of patterns to sum the total percentage value for existing biophilia or proposed new-build projects. The author added to this document and explained how to use the same table of patterns to make connections between indoors and outdoors. She also explained how designers and architects should be able to draft specific questionnaires and get answers from the users of buildings and their surroundings by using the same table/matrix of the Biophilic Healing Index of ten basic patterns in it.

It has been clarified that:

> Trying to quantify biophilic effects makes the assessment of architectural projects more objective. We ought to be able to predict the healing effects of specific environments before they are built. This robust scientific approach contrasts with the usual assessments of architects based on dubious aesthetics. Ten factors responsible for biophilia can estimate the biophilic content of any physical setting. (Salingaros 2019)

The model mentioned above:

> … adds these ten biophilic criteria together into a single number. Instead of merely counting the number of biophilic factors present in a building or urban space, a simple numerical estimate permits a more accurate result. In fact, this method was developed earlier to measure organized complexity as the analogy of "Life" in a building (Salingaros 2006 and 2008).
>
> We can estimate an integer value from 0 to 2 for the intensity and presence of every one of the ten biophilic qualities as follows.
>
> *Estimates*: {none = 0, some = 1, a large amount = 2}.
>
> *Definition*: *"Biophilic index B"* = Light + Color + Gravity + Fractals + Curves + Detail + Water + Life + Representations-of-nature + Organized-complexity.
>
> *Range*: $0 \leq B \leq 20$. (Salingaros 2019 and 2020)

The following points were also discussed with the author's students during the lecture and subsequent debate in February 2021:

> Summing the estimates for the ten individual qualities gives the "biophilic index B", which is a number ranging from 0 to 20. This metric is useful in assessing the biophilic content of different buildings. We can compare buildings in distinct architectural styles, from different periods and locations, and in different shapes and sizes (independently of the usual stylistic concerns, which play no role in this model). The biophilic index works for different locations within a single building, and to compare interior with exterior spaces, open with closed spaces, etc. The index thus enables us to measure the biophilic —hence healing— impact of very different buildings in a relatively objective manner. (Salingaros 2019 and 2020)

The Biophilic Healing Index (BHI) as a professional tool gives us the opportunity to measure its impact on people as a percentage of biophilia. Each given value multiplied by 5 can give us 0% to 10% and all ten values summed can give us 0% to 100% biophilia. It is thought that total values under 50% must be carefully analysed to find what is really 'missing', so that retrofits and/or new designs could safeguard improvements to both spaces and people's lives simultaneously. The BHI is also useful to make recommendations for future improvements, as it shows weaknesses in the way we use our buildings. The BHI could be easily combined with other frameworks and models based upon a variety of theories and practices aiming at active living in an inclusive built environment and effortlessly accessible urban space at the same time.

4. Teaching the Biophilic Healing Index to Higher Education students – applications in final year projects of architectural design – Case study and proposals for Markeaton Campus and the surrounding areas, University of Derby, East Midlands, UK

In the academic year 2021-2022, as a module leader and tutor, the author delivered lectures, workshops, and seminars for Module 6AZ503 Project Research and Urban Design for Year 3 students in BA (Hons) Interior Architecture and Venue Design. The Assignment Title was: "Biophilic urban design and planning for 2030 Derby Daring City: Biophilic Patterns and Sustainable Development Goals (SDGs) in Joint Action for Urban Transformation". The module has been designed to provide the students with the opportunity to research and develop ideas for specific urban areas. In 2021-2022, the students were given a brief that required them to carry out research and create a proposal of urban transformation for a large part of the University campus. They were instructed to pursue deep contextual, theoretical, urban, and technical research leading to a distinctive idea of urban planning and design development.

In the introduction of their assignment the following points were highlighted:

> You will be expected to develop concepts from a "masterplan to a working detail", formulate design proposals and produce a portfolio of appropriate information that clearly communicates your ideas development according to theories and practices which link existing and new architecture to new urbanism. You will be also expected to critically appraise the given brief and undertake site analysis related to a specific area of your choice. Special consideration should be given to the theoretical and contextual underpinning of the final response to the brief.

> Hence, you will produce an appropriate response (design intent), demonstrating the awareness of all relevant contextual issues and developments in the use of advanced urban design techniques to develop the cities of the future with a vision to adapt to urban transformation via Voluntary Review Plans steered by Sustainable Development Goals (SDGs) and specific indicators. Hundreds of Daring Cities around the globe have already started their Voluntary Review Plans through participatory activities and network initiatives. Streets, piazzas, and neighborhoods are going to be transformed into multifunctional urban spaces of social mobility. Endorsed by academia, citizens and policymakers will be able to act and tackle issues of climate change and other unexpected hazards by tagging their interventions with applicable SDG indicators and setting specific targets and timescales of transformation. (The author. Introduction in 6AZ503 Assignment Handbook 2021-2022)

In the brief description, the students learned:

> This assignment requires students to research individually and gain an understanding of theories of Biophilic Design and Biourbanism and related to parallel developments in Urban Design and Planning; you should carry out the necessary research on cutting-edge ideas, such as concepts and technologies of the latest decades related to New Urbanism. You should be inspired by precedents and well-known urban designers and/or landscape architects' work. You should consider sustainability in materials and processes of community participation in urban design.
>
> This part of the assignment requires students to research and evaluate current and future trends in innovative developments in urban design and use designs and technology of human scale-oriented proposals, concepts and/or functional solutions. The result of research and evaluation of findings should be a proposal of urban design. Your work would consider current literature and frameworks supporting collective wellbeing, such as the Biophilic Healing Index; you may wish to evaluate the impact of emerging legislative and other frameworks, such as participative projects and their applications or current planning legislation.
>
> You should create an individual design solution for a specific environment by proposing and evaluating your solution inside a set of contemporary urban regeneration and new development context in terms of its sustainability; you should explore innovative approaches (and their likely outcomes). However, you should also work on current trends in urban design and planning which not only focus on the regeneration of urban areas, but also on restoring growth and social cohesion in local communities, and especially after the pandemic. Thus, you are expected to choose your area of intervention within Derby City and/or immediate surroundings (the main recommended area of focus for research and intervention should be the University campus and its links to the city); your proposed urban transformation will be tagged accordingly by precise SDGs acting as underpinning platform to your project. The size of the area will be agreed with your tutor; you should develop an idea of urban transformation for an area that may contain a local network of paths, streets, or nodal points, such as piazzas and important facilities equally for local inhabitants and visitors.
>
> A physical A3 or electronic format portfolio (one or more folders) will be produced, containing relevant research on precedents and especially research on inspiring designers and architects who have created and are still creating innovative urban designs; you should include illustrations, sketches, photographs, and annotations, plus final drawings of your proposal. You should also include your measurements and considerations related to the *Biophilic Healing Index (BHI)*, and your suggested indicators and Sustainable Development Goals (SDGs) to be eventually set for implementation of your proposal (and integration into the local/city masterplan). (The author. The Brief in 6AZ503 Assignment Handbook 2021-2022)

The students considered the historical context of the sites, and social and economic factors of the surrounding areas, containing housing, schools, green parks, allotment fields, etc. The entire area presents several problems: car traffic and pollution, abandonment of sites between Markeaton Park (near Markeaton Campus), and Britannia Mill (another University building, ex-industrial historical site). See Figures 1, 2 and 3 below, in which pathlines of communication were also traced (Cycling routes are highlighted in yellow in Figure 2). The Biophilic Healing Index (BHI) was measured for existing conditions at 35%. One of the students of this cohort, Amen Feresenbet decided to propose interventions to increase the BHI at 70-75% as a minimum.

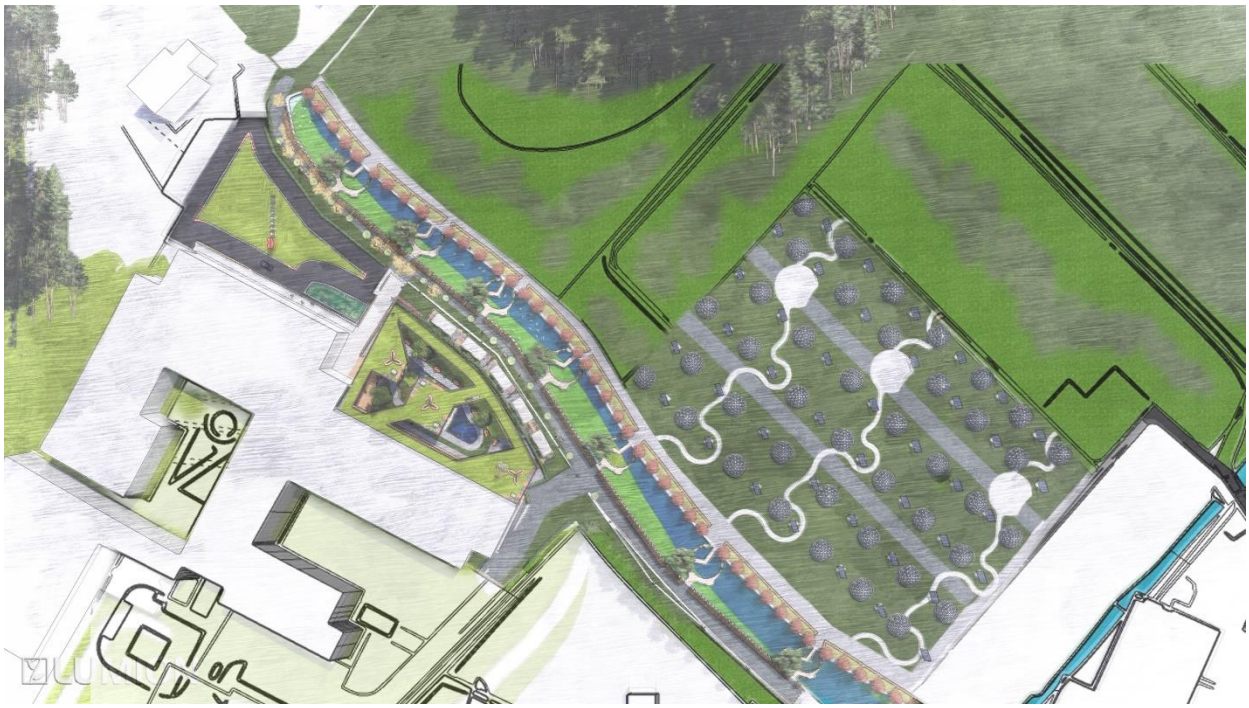

Figure 1: Markeaton Campus site plan including external social and educational spaces (drawn by Amen Feresenbet)

Figure 2: Walks and cycling routes along the brook in Markeaton Campus (drawn by Amen Feresenbet)

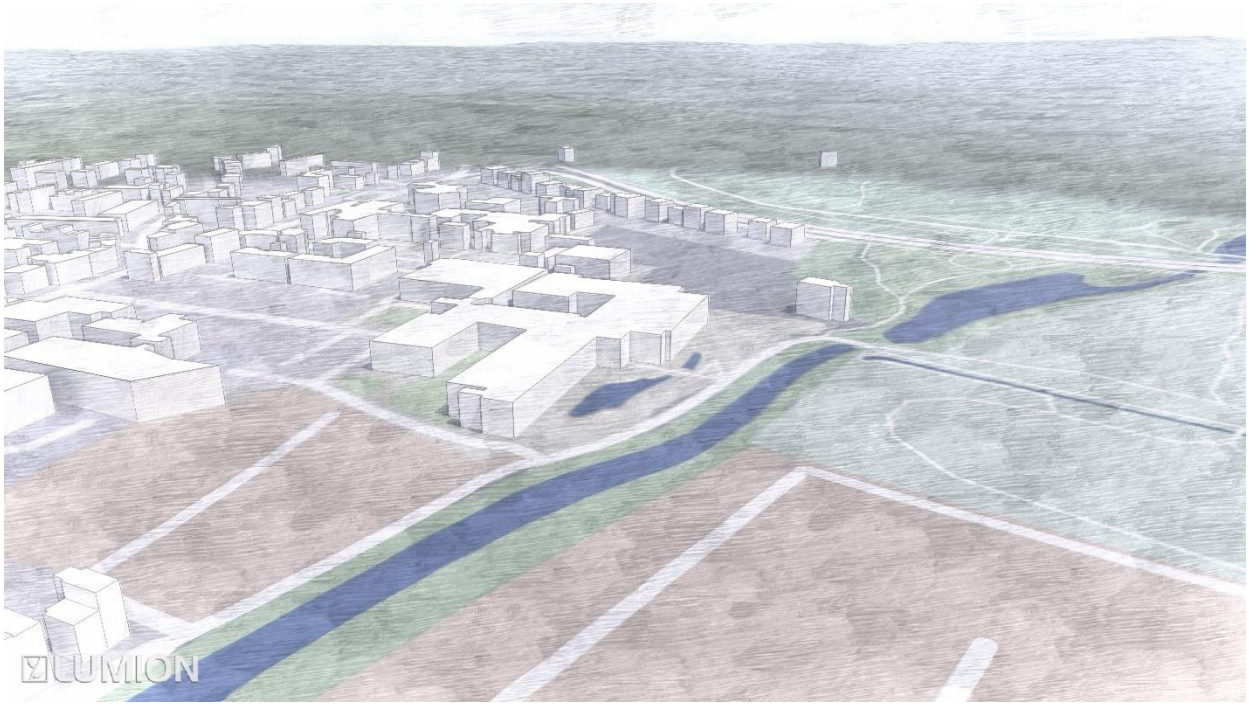

Figure 3: 3D Sketch model representation of Markeaton Campus (drawn by Amen Feresenbet).

Key points considered by Amen Feresenbet by referring to Sustainable Development Goals:

- Ensure healthy lives and promote well-being for all at all ages (SDG 3).
- Reducing inequalities for persons with mental impairments or psychosocial disabilities (SDG 10).
- Making cities and communities inclusive and sustainable for persons with disabilities (Goal 11).
- Take urgent action to combat climate change and its impacts (SDG 13).
- Conserve and sustainably use the oceans, seas, and marine resources for sustainable development (SDG 14).
- Protect, restore, and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss (SDG 15).
- Promote peaceful and inclusive societies for sustainable development, provide access to justice for all, and build effective, accountable, and inclusive institutions at all levels (SDG 16).

The student used SDG Indicators, a metadata repository, to understand how he would be able to classify specific indicators for specific areas. So, he managed to highlight and select the indicators as shown on the previous page.

Figure 4: Proposal - accessibility ramp near the entrance of Markeaton Campus (drawn by Amen Feresenbet).

Figure 5: Studio space opens to the public along Markeaton Street front-Rainwater harvesting for ponds and gardens (drawn by Amen Feresenbet).

Figure 6: Balcony extension of the architectural design studio with a view to Markeaton Brook (drawn by Amen Feresenbet).

Figure 7: Pedestrian routes, external exhibition pavilions, accessible routes (drawn by Amen Feresenbet).

Figure 8: Panoramic view of Markeaton Campus (See also video: https://www.youtube.com/watch?v=coIz4Pagg4I) (drawn by Amen Feresenbet)

Figure 9: Public route through student exhibitions towards Markeaton Park and the allotment areas (drawn by Amen Feresenbet)

(Figures 1-9, ©Amen Kidane Feresenbet, Year 3 student in BA (Hons) Interior Architecture and Venue Design, Module Project Research and Urban Design Project, academic year 2021-2022).

5. Conclusions

The projects have been exhibited during the final year exhibition and attracted a lot of attention from the local community visitors. Some students have either decided to apply for jobs that have to do with urban biophilic design and others have continued their studies in our MSc in Sustainable Architecture and Healthy buildings. And now some students carry on with PhD studies in applications of Artificial Intelligence in Architecture with intention to insert the Biophilic Healing Index as an important tool to design and monitor healthy cities for the future. So, we have started

training professionals with new and essential tools for their practice to help cities recovering after all these recent restrictions and hardship.

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Appendix A.

Computing the Biophilic Healing Index Nikos A. Salingaros 2021 (February 2021 – disseminated and explained in Annual Lecture in the academic year 2020-2021)

"We can quantify Biophilia through the Biophilic Healing Index. This gives a percentage score evaluation of how biophilic a design actually is, which combines estimates for ten separate biophilic qualities. Here are the background references:

https://www.terrapinbrightgreen.com/report/biophilia-healing-environments/

https://applied.math.utsa.edu/~yxk833/BiophilicIndex.pdf

Estimate ten geometrical plus natural qualities listed below according to the scale: 0 = none, 1 = some, 2 = a lot:

B1. Sunlight: preferably from several directions.

B2. Color: variety and combinations of hues.

B3. Gravity: balance and equilibrium about the vertical axis.

B4. Fractals: things occurring on nested scales.

B5. Curves: on small, medium, and large scales.

B6. Detail: meant to attract the eye.

B7. Water: to be both heard and seen.

B8. Life: living plants, animals, and other people.

B9. Representations-of-nature: naturalistic ornament, realistic paintings, reliefs, and figurative sculptures — including face-like structures.

B10. Organized-complexity: intricate yet coherent designs — and extends to symmetries of abstract face-like structures.

Sum the values for the above biophilic components to define the index B as a number out of 20. For B as a percentage score, simply multiply this total by 5. A quantitative measure of the degree that a design is biophilic is more useful than the usual vague discussions based on images showing potted plants. The more biophilic it measures on this scale, the more a building will contribute positively to the users' health. This phenomenon has been established by medical measurements. And the whole point is to compare different buildings and competing designs to check their biophilic qualities in relation to health and wellbeing.

NOW: We can estimate biophilia in Urban Space (Eleni's validation of the Biophilic Healing Index as a professional tool to design buildings and urban space, such as cityscape/streetscape, piazzas, etc.)"

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