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25 April 2024

REGENERATIVE
DESIGN IN DIGITAL PRACTICE
A Handbook for the Built Environment

Edited by
Emanuele Naboni
Lisanne Havinga

cost
EUROPEAN COOPERATION IN SCIENCE & TECHNOLOGY

RESTORE
REthinking Sustainability TOwards a Regenerative Economy

Cover Image - The Spiral, New York

Located at the intersection of the High Line and Hudson Park, The Spiral extends the green space of the former train tracks in a spiraling motion towards the sky – from High Line to the skyline. Reminiscent of the city's classic setback skyscrapers, The Spiral stands out for its shared open space on every floor. At each level along the ascending path a terrace connects to a double-height atrium for meetings and events with views across Manhattan.

Courtesy © Bjarke Ingels Group

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Regenerative Design in Digital Practice
A Handbook for the Built Environment
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REGENERATIVE DESIGN IN DIGITAL PRACTICE

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BIG DATA, SOCIAL NETWORKS AND WELL-BEING

Dario Cottafava *University of Turin, Italy*

Social Networks aimed at understanding well-being could sustain the shift in paradigm from Sustainable to Regenerative Design. Well-being, i.e. '*the state of being comfortable, healthy, or happy*', is a concept related to happiness, positive experiences and pleasure with implications on physical, mental, social and environmental aspects [1]. In the built environment, recent works have linked indoor comfort, as well as long-term mental health and illnesses, to Indoor Environmental Quality (IEQ) [2]. Further studies focusing on outdoor spaces were conducted on the relationship between landscape and well-being [3], proving how urban landscapes affect the physical, mental and social well-being and health of citizens. Recent studies have also shown a positive impact of social ties on health [4] and the value of adopting a socio-ecological approach to co-benefit individuals and the ecosystem, thus calling for integrated governance of social-ecological systems [5]. However, there are only a few projects that focus on the integrated governance of a social-ecological system with ubiquitous technologies, and these projects are highly focused on human-centric design rather than on an eco-centric perspective [6]. Ubiquitous technologies, also defined as ambient intelligence [7], refer to sensitive environments where computing is available everywhere at any time and may allow a more regenerative design by taking into account all the components of an ecosystem and their interactions.

FROM HUMAN TO ECO-CENTRIC PERSPECTIVES

The sustainable development definition, officially introduced by the Brundtland Report [8], reflects the anthropocentric view in which rights and duties are only attributed to humans. This view has been criticised since the 1970s when the sustainability debate emerged. According to the Deep Ecology ethics [9] - *the development would not be right if the ecosystem is significantly affected by it* - rights and duties must also be prescribed to smarter animals, sentient beings, living beings and *beings in existence*. In 1984, *'A Cyborg Manifesto'* introduced the Posthuman theory, rethinking the human experience and establishing the idea of a collective nature [10].

It is argued that humans cannot control the ecosystem, but they are a part of it together with non-human entities, living and non-living objects. This new paradigm is embodied in the *Sustainable-Restorative-Regenerative* shift [11]. *Sustainable* represents an old anthropocentric viewpoint that is focused on limiting negative environmental impacts. *Restorative* design highlights an approach to restore eco-, social and economic systems to a healthy state, and the new paradigm represented by the *Regenerative* approach, which aims to enable ecological, social and health co-benefits.

In the next section, three pilot projects explore indoor and outdoor human well-being, comfort and health in parallel to the above mentioned ecological, social and health co-benefits: 1) *ComfortSense* adopted a Mobile Crowd Sensing approach (MCS) for Adaptive Thermal Comfort, 2) *HOME (Human Observations Meta-Environment)* explored the direct interactions between occupants and the building to improve indoor comfort and reduce the energy consumption of Heating, Ventilating and Air Conditioning (HVAC) systems, while 3) *First Life* tested a Neighbourhood Social Network to foster citizens' interactions in identifying specific places within the city with positive or negative implications for well-being and health.

MOBILE CROWD SENSING APPROACH (MCS)

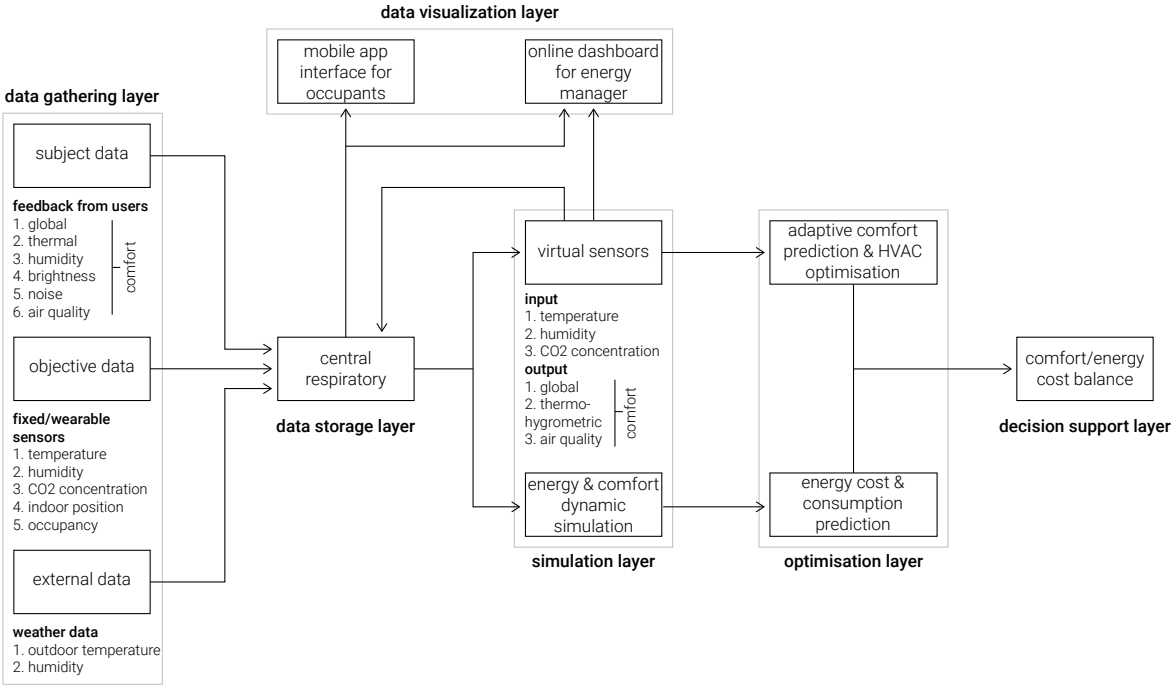
A recent project, *ComfortSense* [12], was aimed at improving users' comfort while reducing energy consumption by exploiting a machine-learning algorithm to correlate Objective variables (Temperature, Humidity and CO_2 concentration) with Subjective feedback from users. The personal feedback was gathered through a mobile app, thanks to a Mobile Crowd Sensing approach [13], to stimulate a behavioural change process in occupants to adapt the building in response to the users' perception. Figure 15 shows the IT infrastructure designed to interact with people (data visualisation) and with the building (optimisation) to improve the whole system (decision support) by reducing the energy consumption and improving occupants' indoor thermal and visual comfort.

ComfortSense was based on an Adaptive Comfort approach [14]. The Adaptive Comfort models are based on the idea that people, by interacting with the building or the environment, can control the environmental conditions, such as the indoor temperature or the relative humidity. In particular, ComfortSense linked users' feedback to Indoor Environmental Quality (IEQ) monitoring in real time by exploiting the smartness of collective intelligence, i.e. a crowd/group may often make better decisions than any single member of the group [15].

A regenerative state can be activated by considering that occupants tend to forgive more, e.g. they may accept higher indoor temperature during the summer if they have more control over the building itself [16]. Taking into account the basic principle of adaptive thermal comfort, ComfortSense showed how indoor comfort could be improved to achieve health co-benefits for humans (reduction in headache, nausea and dizziness) and for the environment (reduction in consumption [12]).

Figure 15

Information flow of the ComfortSense project. The six layers allow interactions among occupants, the building and the energy management. The data gathering layer collects data from sensors and occupants which are first stored into the data storage layer, then used to train the predictive algorithms (simulation and optimisation) and finally organised for users (data visualisation) and energy management (decision support).



HOME (Human Observations Meta-Environment) [17] focused on the use of Social Networks for improving well-being and thermal comfort by exploring the process of *environment-emotions-health* [18], i.e. how the surrounding environment affects, positively or negatively, peoples' emotions and how the latter may affect human health. For this purpose, HOME created an interactive environment where occupants act together with the building via social media feedback. Users control the indoor temperature by sending messages, such as 'up' or 'down', or by writing comments that are captured by the software Human Ecosystem [19]. Signals were correlated to indoor temperature, humidity, occupancy density and users' movements tracked with videos processed by the OpenCV library to transform video information into data. Causes of discomfort and unhealthy states were analysed by looking at the emotions manifested in comments. Figure 16, 17 and 18 show three screenshots of the possible visualisations used to analyse users' feedback and sentiments.

Figure 16

Screenshot from the Human Ecosystem dashboard analysing posts from social networks. The comfort/energy distribution (bottom-left) shows qualitative classifications of comfort/energy. Each post/tweet has been classified by two parameters, comfort and energy, by assigning two values to words within the scraped sentence in order to explore the phase space of the Circumplex model of emotions. The energy parameter defines an active or passive action, while comfort describes a positive or negative concept.

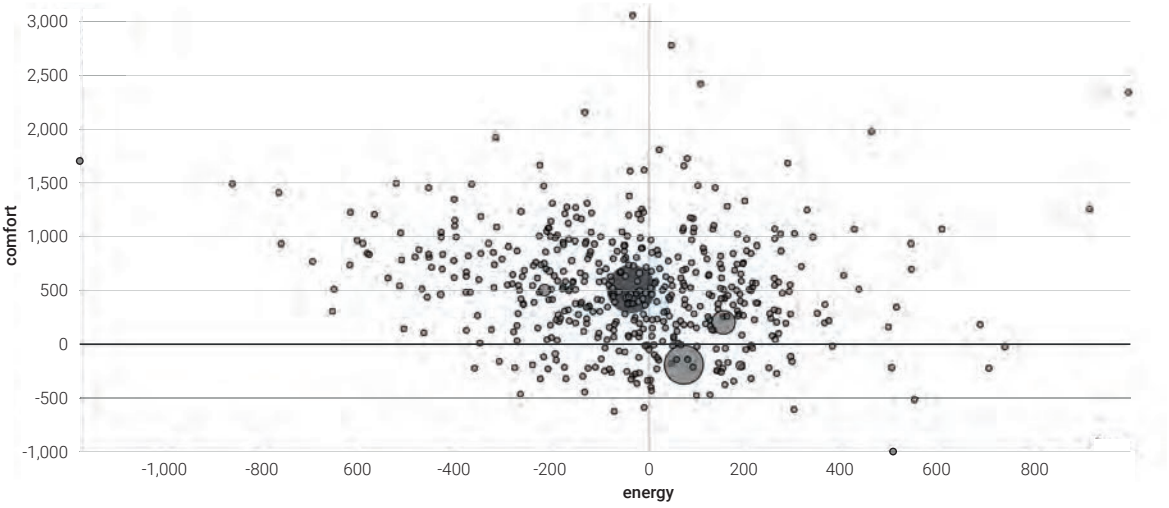


Figure 17

Screenshot from the Human Ecosystem dashboard analysing posts from social networks. The wordcloud highlights the most frequent words appearing in scraped posts and tweets.

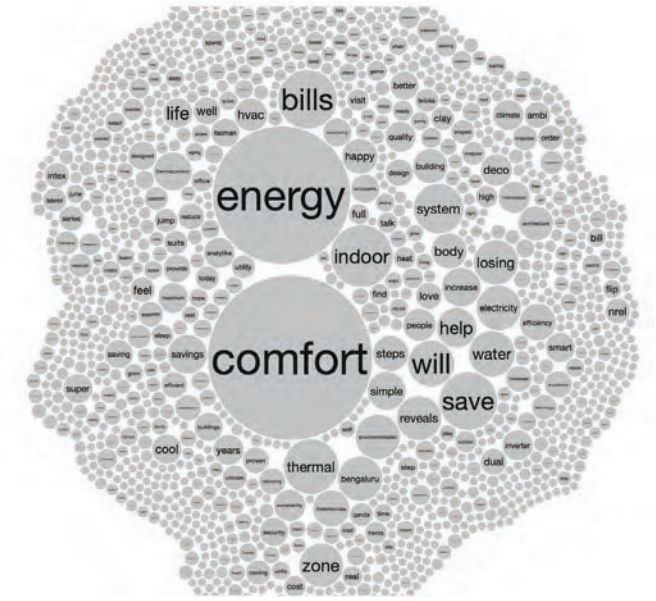
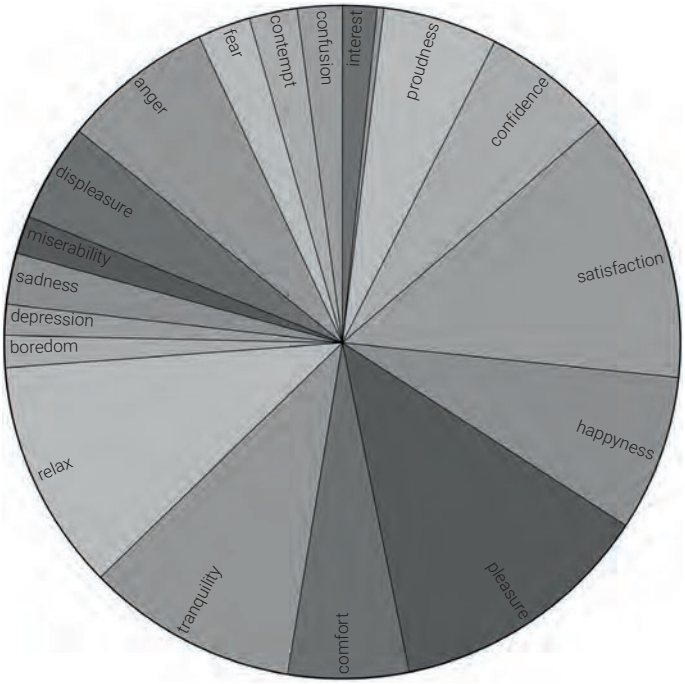


Figure 18

Screenshot from the Human Ecosystem dashboard analysing posts from social networks. The piechart summarizes the most frequent sentiments of the scraped posts/tweets. Emotions are defined with precise keywords belonging to the Circumplex model of emotions such as Happiness, Tranquillity,Displeasure and so on.



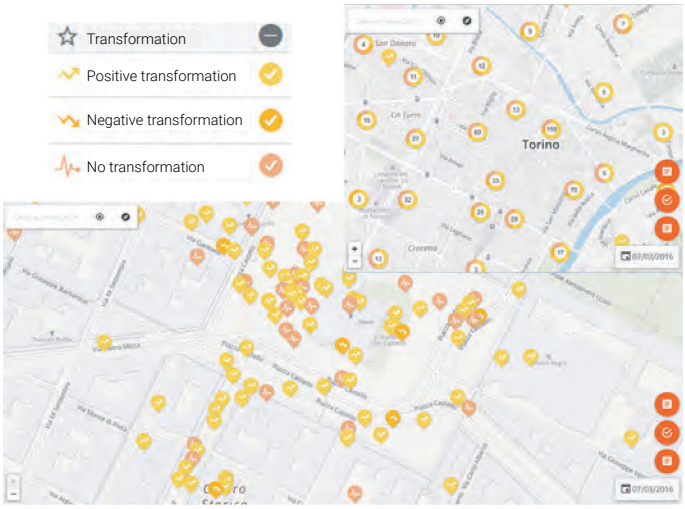


Figure 19

Screenshot from the First Life web platform. The map shows the current transformation occurring in a place within the City of Turin, as perceived by the citizens engaged within the project. This map is only one of the available visualisations of the First Life platform [20].

FirstLife [20] is a web platform for Computer Supported Cooperation aimed at fostering co-production of urban landscape knowledge. It provides a virtual place, a *Neighborhood Social Network*, where citizens can interact and participate in city life. FirstLife can be exploited as a pure Digital Urban Acupuncture (DUA) approach to explore the daily microhistory of citizens. The DUA approach is an innovative approach, introduced by Iaconesi et al. [19], useful in identifying the *Pressure Points* between citizens and the urban landscape, or between occupants and a building.

The Pressure Points are the contact points which cause conflicts among the different actors, i.e. citizens/occupants and the buildings/urban landscape. Indeed, concerning personal indoor comfort and according to the main principle of Adaptive Comfort - *if a change occurs such as to produce discomfort, people react in ways which tend to restore their comfort* [14] - such points represent the most interesting part of the occurring interactions between actors and the environment. Once the pressure points are identified, new punctual strategies may be adopted to improve actors' comfort, well-being and health.

For instance, decision makers could focus on unhealthy places and plan to redesign them in a regenerative way by taking into account natural and artificial places appreciated by the citizens, such as small court gardens or fountains, which have positive implications on community health [3] but are typically underestimated from the decision-makers' point of view. Thus, thanks to this approach, a more Regenerative city, able to co-benefit humans and the environment, can be designed. Figure 19 shows an example of visualisation from the First Life platform, where positive and negative transformations as declared by the citizens, are highlighted and geo-localised to support the decision-making process of urban planners and policymakers.

To sum up, the substantial implications of the surrounding environment on human indoor and outdoor comfort, well-being and health have been widely investigated in the past decades, but previous research has mainly focused on a human-centric perspective. The presented approaches and the use of ubiquitous technologies could help in understanding dynamic relationships between humans and the environment, which would, in turn, allow better applications of Regenerative Design for the built environment and the urban landscape. More in-depth investigations into the adoption of integrated governance, are needed to consider the main dynamic interactions in real-time, i.e. the Pressure Points as defined by the Digital Urban Acupuncture approach.

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