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DESIGN TO THRIVE

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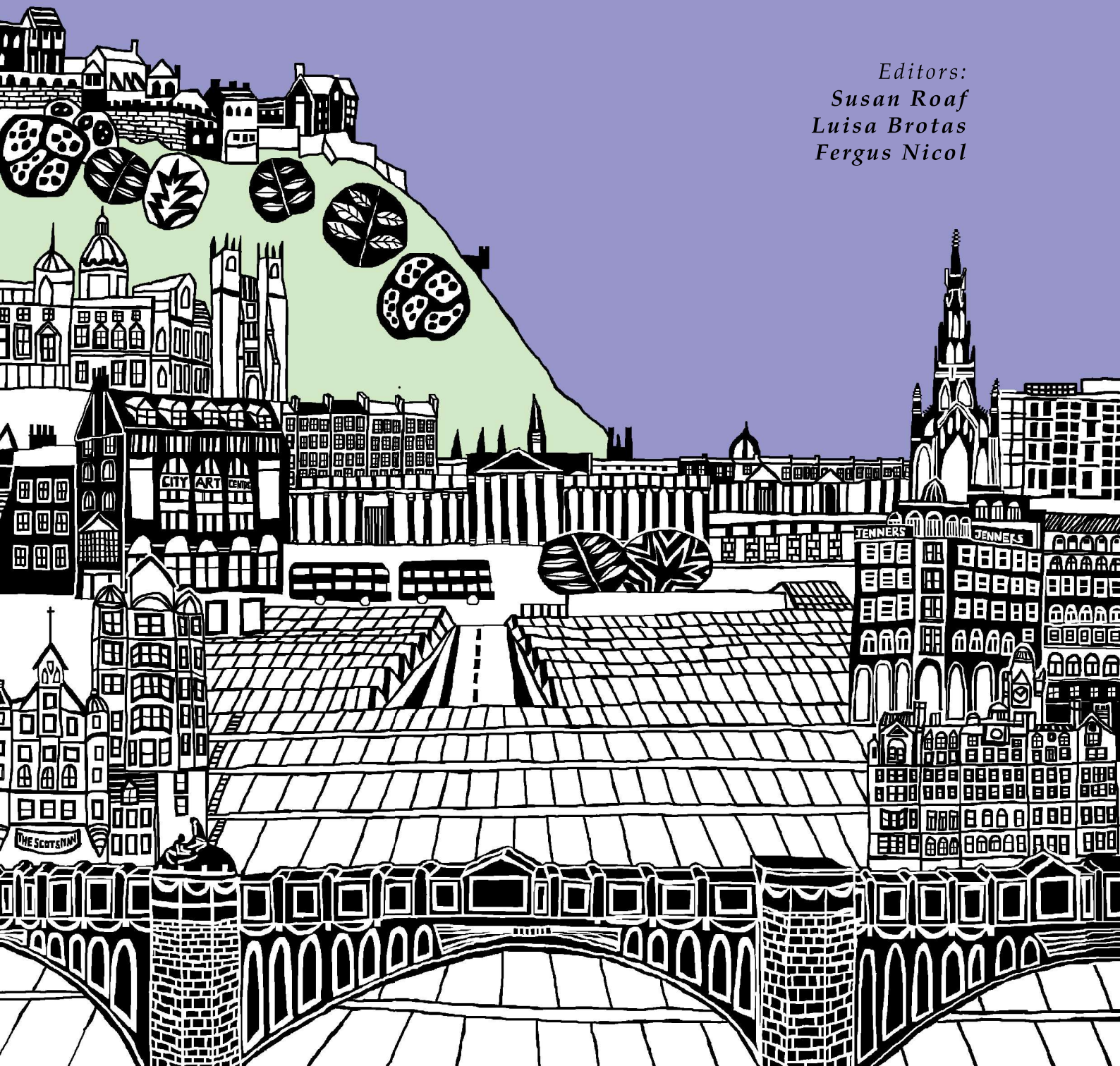

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Overheating

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With the steep rise in global temperatures, overheating is one of the most visible effects of climate change on buildings. Further to forecasts more frequent extreme weather events and longer and warmer summers, the risk of overheating may well become one of the primary causes of building system failure. Present buildings need to invest a considerable amount of their energy usage to reject heat gains, or have the need but not the capacity to. This is particularly true in warm regions but more and more often, this situation has become present in traditionally cold areas as well. The increase in internal loads or the use of architectural designs poorly suited to the local climate, such as over-glazed façades or, paradoxically, over-engineered insulation, is increasing interior overheating exposure time in many buildings, even in winter-dominated climes. This intensifies the vulnerability and weakens the resilience of many contemporary buildings to climate change-associated events, even the most modern developments and high performance buildings designed under Passivhaus standards (Botti).

Overheating mainly affects comfort conditions, but can also lead to health problems, including a reduction in life expectancy or risk of death in the most vulnerable occupants (Gupta, Renganathan, Fosas). User productivity is likewise affected both at home and at work (Gupta, Botti, Calleja). That, together with possible rises in energy consumption and their impact on power generation and distribution systems (particularly electricity grids) make this a problem of public concern nature.

It does not seem possible to establish a single definition of overheating, and this topic has been one of the key drivers of discussion within the forum. We may associate with conditions in which building users are exposed to high thermal stress over periods of time long enough to interfere with body thermoregulation beyond their individual habituation and physiological adaptation capabilities. The issue is not only related to air temperature, but also factors such as air currents, activity, radiant temperatures and other environmental parameters also play fundamental roles (Quezada, Vallejo-Torres, Fosas). The analysis from the perspective of dynamic adaptive comfort and non-linear occupant's response have been drawn as one of the most appropriate approach.

In light of the foregoing, the forum has addressed, some questions listed below to deal with the assessment of the issue and to design the most effective strategies.

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Evaluating the risks

A key question is whether we can predict overheating, and mainly, do we agree with the actual definition of Overheating and their metrics? This aspect opens a debate with a broad difference in the approach between temperate and cold climate areas.

There is plenty room for discussion about the Overheating metrics and the threshold fixation. There is an especial relation with cultural and regional factors, so these parameters must be considered with special care in any procedure. From this reflection emanates a basic question: Is it possible to make an accurate assessment of the actual issue?

Inhabitant's behaviour and characteristics have a deep impact in the overheating phenomena, with greater effect on older users because of the longer stays periods and being less responsive (Gupta).

Our architectures should develop an important adaptive and flexible component so that occupants can use different techniques of heat control. This must be adapted to their pace of life and individual specificity providing tools to help them control the overheating of the indoor ambient. These may include an intelligent use of ventilation (preferably natural) and shade management. To this end, the use of a low-hi technology mix, such as the combination of passive systems and the new automated control elements, may be of interest to keep the environments controlled with little investment of energy. This aspect has a special impact improving resilience and adapting to aging process.

The development of realistic and useful prediction models for Overheating forecasting its becoming a real need. We must to make a special effort to arrange opportune and accurate data, especially those of meteorological type and the need for more advance techniques for interpolation of meteorological data between stations (Oraiopoulos). Promising proposals for models based on trends and those components with cyclical behaviour are under development, such the ITCC-TSAM model (Oraiopoulos), or the use of Kriging-based interpolation for models (Wood). The development of proposals for tools to apply in the residential development industry, such as the ARIOS tool, optimized for regional typologies, sets a path for further involvement (Tsukiyama).

Special consideration should be given to architectures with fewer capacities, which cannot afford the classical thermal stress mitigation resources, such as envelopes with suitable mass or adapted materials. Usually these constructions are located in the most disadvantaged areas of the planet, where the scarcity of resources forces to very light or limited quality constructions. These housing models are extremely vulnerable to overheating processes, making living conditions even more painful. An especially extreme case is the temporary construction in refugee camps, which are usually located in areas especially sensitive to extreme climates, such as the desert plateaus of the Middle East. Many of the low-resource architectures have had to deal with the debate sacrifice traditional heat protection techniques, such as the use of thermal mass, for cheaper and faster constructions. There is a significant field of development to achieve the improvement of the behaviour of these elements, while being compatible with a fast and affordable construction.

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Strategies for adaptation and mitigation
The forum covered different techniques to design the most suitable strategies for building design, focusing in particular on existing buildings and what actions may be undertaken to improve the response to overheating.

Overheating fighting is strongly related to good design practices and morphological optimization of the buildings. Most of the strategies to be incorporated are usually based on traditional elements, which have been used to great effect in the vernacular architecture, in many cases still in use in the traditional home stock of mild temperate zones. Many strategies are simple in theory (natural ventilation, shading, the use of water and other techniques) although providing adequate solutions to remove or block the heat in an effective way is harder to achieve in real practice for modern developments.

Are those mechanisms historically deployed applicable to today's uses and language? We have to explore and gain knowledge from this traditional and vernacular adaptation to improve the performance of contemporary buildings.

One of the usual problem is that most of the solutions derive from rule of the thumbs approaches. Accurate and scientifically based approaches may displace wilful and sometimes naïve design. Different tools are available to assess the design and to optimize with a parametric approach for every specific circumstance (La Roche). This allows a more accurate and climate responsive design.

Proper control of the heat gains of buildings does not have to be at odds with the freedom of design and the quality of the architectural product. The control of energy gains should not be understood as a linear and rigid imposition, but instead, on most occasions provides enriching elements to the creative process (La Roche, Calleja).

The forum has explored truly feasible and cost-effective solutions, with a look to side effects, such in other buildings components or neighbouring zones (Grant).

Control of the windows and facade shadows, especially in high-rise buildings (La Roche, Gavira Calleja), as well as roofs design in lower buildings (Quezada, Grant); appear as key elements in the overheating control for buildings. We can consider alike other contributions with significant weight in the control of the heat gains such the control of the radiant temperature of indoor envelope. This may be achieved through different techniques getting cooler surfaces, like the reflective coatings, evaporative techniques, and cross-section materials optimization (Grant, Habib, Vallejo-Torres).

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Conclusions

- A non-deterministic assessment to the overheating issue, mostly based on the adaptive comfort theory will help to realistic evaluations.
- A crucial issue will be how to design effective retrofitting approaches that do not worsen the problem.
- The dilemma between over-insulating and the overheating risk must be undertaken. How to strike a balance in a changing and dynamic climate?
- How we can apply the different strategies to the current building stock?
- The morphological components of architecture play an extremely important role in the control of overheating: windows, shapes, materials and shadows must be handled accurately.
- A holistic, comprehensive, and sometimes painstaking approach to the problem is needed to design actual adaptable buildings.