Performance-Oriented Design
Precursors and Potentials
Its a bit nippy? Turn on the heating. Its too hot and humid? Turn on the air-con. Jolly good! Except, if your permanent address is Planet Earth you might have heard of climate change and the inconvenient truth seems that we accelerate it, heating, cooling and ventilating the hell out of our environment by means of energy-consuming equipment. The extent to which we do this is exorbitant. During last years hot summer the power grid of California failed at some point due to the vast amount of air-conditioning units being used. When the power grid holds up, the carbon footprint is gargantuan. But hey, you hear them say, air-con is a status symbol, a hallmark of modern life, the only way to secure human comfort. Or is it?

It is now widely appreciated that carbon footprints and intensive energy consumption need to be reduced. But the question is how? The bulk of research and legislation in the EU that is geared towards sustainability of the built environment aims for so-called zero-energy buildings. This is pursued by reducing thermal loss or impact through increasing amounts of thermal insulation, electrical thermal regain equipment and the reduction of energy consumption for interior climate modulation. Consequentially, and quite obviously, this approach reinforces the strict dichotomy between interior and exterior that came hand in hand with the emergence of these devices in the first place. We have thus inherited an uncontested solipsistic spatial paradigm that is dictated by and, in turn, dictates the way we think about the homogeneous modulation of almost hermetically sealed interior environments.

If, on the other hand, one mentions passive strategies for environmental modulation, it may be welcomed by some as, at best, supplementary to active electrical systems, or condemned by others as a nostalgic reflex that will surely sacrifice comfort at large, turning our built environment back into an infested medieval slum. This fear is quite obviously strategically induced and nourished by energy politics, providers and industries that wish to collect taxes and make profits. Only a few seem to actually consider that updating passive strategies to a contemporary technical context may be a very powerful opportunity for architecture to rethink its preferred spatial paradigm. It thus seems that while we have returned to a preference for heterogeneous space, we are not able to transcend beyond the limit of mere utilitarian environmental consciousness to understand the potential of a broader notion of performativity, as well as the synergy between material arrangements, microclimatic conditioning of space and interrelated migratory activities.

In order to initiate a revised take on this topic, it is necessary to re-evaluate some historical precedents. To pursue a broad account of historical precursors of performative design and passive environmental strategies would vastly exceed the possible scope of this article. Instead only three

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areas of perceived potential will be briefly discussed: functional building elements with regards to the articulated surface; heterogeneous spatial arrangements facilitating varied microclimates and gradient thresholds that in turn are related to dynamic modes of habitation; and bodies in space with their own energy signature. It is needless to say that material surfaces already interact with the environment, they partition space in some way and condition it by means of exchange with an environment, and environmental gradients do not only emanate from matter that delimits space as material surfaces, but also from the living bodies that move in space and time. The question is how such strategies can be updated and instrumentalised with regard to the dynamic relation between subject, object and environment and towards a critical spatial paradigm.

There are many interesting examples in vernacular and representative architecture alike concerning the utilisation of articulated performative surfaces. Great examples are screenwalls, particularly in Islamic architecture. Sophia and Stefan Behling posited that the dream of Mogul architects was to create the ultimate diaphanous wall. The multifunctional screens ... allowed the greatest comfort in inside/outside spaces.  Such screenwalls include the Indian jali or the Arabic mashrabiya. A jali is a perforated stone screen, while a mashrabiya is a projecting bay window articulated by wood latticework. Visual connection from the interior to the exterior is provided, while visual penetration from the exterior to the interior is prevented, offering privacy to inhabitants. Such screens enable ventilation, provide shading and modulate the luminous environment of the interior. The Behlings argue that Mogul screens are far more sophisticated than modern devices for creating shade. The filigree designs and the dramatic display of light and shadow create virtual spaces within rooms. Screenwalls and similar building elements have already consolidated what Reyner Banham called the Western tradition of substantial architecture with the non-substantial one of societies who do not build substantial structures [but instead] inhabit a space whose external boundaries are vague, adjustable and rarely regular. Such elements constitute no less than the awesomely beautiful performative synthesis of the delineating material threshold and the environmental gradient.

Contemporary versions of screenwalls range from the sculptural experiments of the Austrian sculptor Erwin Hauer, commencing from the early 1950s, to current non-standard assemblies that utilise parametric associative modelling environments to inform the design of highly performative screen walls. One interesting move forward would be designs beyond simple flat-screen applications into layered envelopes for entire buildings, as can already be seen in some Mogul architecture. The use of such elements may also not only be constrained to hot climates. Lace villas in Northern Europe, so called because of their white-coloured timber latticework that resembles lacework, deploy such screens to provide porches that are protected from wind in the winter while permitting sunlight at a low angle, as well as shading and ventilation in the summer.

Articulated surfaces also include possibilities other than screenwalls; for instance, poche walls or surfaces with non-
The Ali Qapu palace located on the western side of Naghsh-i Jahan Square in Esfahan, built in its initial form by Shah Abbas I in the early 17th century, received under Shah Abbas II a music room on the sixth floor with remarkable walls and ceiling vaults. It contains cavities made from delicate stuccowork that invoke the image of bodies of musical instruments. It is likely that these were intended to reduce reverberation while retaining upper and lower tones. Folklore has it that the music could still be heard long after the musicians had left. While this is obviously quite an exaggeration, it is nevertheless a most remarkable historical precedent to performance-oriented design: an architecture that is both an extension of musical instruments and an amplifier of musical performance. What has changed since is that due to contemporary means of form generation, performance analysis and manufacturing, such designs are now affordable for those less fortunate than the then richest man in the known world, the Shah of Persia.

The layering of walls of different thickness or porosity can create a variety of microclimates that can suit individual preferences in terms of comfort and activities. Spatial arrangements and dynamic inhabitation were historically often interrelated. Depending on the time of day or season, activities would shift location in plan or in section. In hot and dry climates, multistorey houses offer the possibility to use the lower floors during the hot day and to sleep on the roof terrace at night where it is coolest. Mogul, Persian and Ottoman pavilions enabled a similar potential for migratory use of space in their careful spatial arrangement in plan.

Seasonal differences in the northern hemisphere might locate activities in the winter on the south-facing side, and in the summer on the north-facing side of the building, and vice-versa in the southern hemisphere. Courtyards, loggias, arcades, verandahs and porches are useful elements for this purpose, although they have almost disappeared from contemporary spatial repertoire due to the strict division between exterior and interior that comes hand in hand with electrical air-conditioning and heating. However, combined surface articulation and orientation and layered spatial arrangements can provide for a heterogeneous space and microclimate in which comfort can be found on the basis of individual preferences and needs, contrary to the prescribed homogeneously conditioned interior of the age of electrical air-conditioning.

This can be complemented by an understanding of bodies in space as energy emitters.

In cold, mountainous climates, for instance in the Alps, cattle were used as a thermal energy source for the space inhabited by humans. Within the envelope of the building, the cattle were placed in the outer periphery around a second walled in area reserved for human use in order to warm up the peripheral space and thus maintain thermal comfort in the inner area. Such strategies were not only used in plan arrangements, but also in section, with the cattle placed on the ground floor and the spaces reserved for human inhabitation placed above. For large auditoria and other such spaces it is relatively common practice today to calculate the heat gain due to the presence of a large number of people. Such methods could be further developed and finely calibrated to differently scaled designs. They may also not only be constrained to thermal modulation, but involve the integration of other organisms for the sake of CO₂ reduction, oxygen provision and so on. This becomes particularly powerful when material properties are once again more carefully, and in a less prejudiced manner, deployed and calibrated to take advantage of their responses to different environmental stimuli.  

The walls and ceiling of the music chamber of the Ali Qapu palace in Esfahan have cavities that are set into the wall with the purpose of reducing reverberation and holding upper and lower tones. In doing so they become an extension of the musical instruments embedded within the architecture of the music chamber. The plasterwork is fantastically intricate, tapering to 3 millimetres (0.12 inches) thickness towards the edge of each cavity. Such work was possible due to an unprecedented accumulation of craftsmanship in one location.

The photo shows the intricate pattern of light and shadow in the Friday Mosque in Esfahan, Iran, affected by a screenwall that also provides ventilation.

uniform thickness. The Ali Qapu palace located on the western side of Naghsh-i Jahan Square in Esfahan, built in its initial form by Shah Abbas I in the early 17th century, received under Shah Abbas II a music room on the sixth floor with remarkable walls and ceiling vaults. It contains cavities made from delicate stuccowork that invoke the image of bodies of musical instruments. It is likely that these were intended to reduce reverberation while retaining upper and lower tones. Folklore has it that the music could still be heard long after the musicians had left. While this is obviously quite an exaggeration, it is nevertheless a most remarkable historical precedent to performance-oriented design: an
Scaled model of the Manifold screenwall system, designed by Andrew Kudless in 2004, exploring a multiple-layer, double-curved and variable depth honeycomb arrangement to modulate visual transparency, light transmission and ventilation. The design exceeds the typical flat screenwall and can act as layered spatial arrangements and as a porous building envelope.

The Meta-Patch screenwall, designed in 2004 by Joseph Keliner and Dave Newton, is an adaptable assembly. Small timber patches are mounted onto larger ones. The small timber patches are bent and twisted by means of bolts that are used as actuators. Through the incremental actuation of each small patch the larger patches become curved and thus the assembly acquires the capacity to bear its own self-weight and hold itself in an upright position. Holes are introduced into the larger patches to facilitate airflow and light transmission from one side of the screenwall to the other upon actuation of the timber patches inducing curvature into the assembly. The interesting aspect here is that the curvature of the screenwall, and therefore its specific performance, can be altered at all times.

The Strip Morphologies screenwall, designed in 2005 by Daniel Coll I Capdevila of OCEAN NORTH, explores a multiple-layer, double-curved and variable-depth bent strip arrangement to modulate visual transparency, luminous, thermal and acoustic performance, and enables layered spatial arrangements by means of a porous envelope.
In the case of the discussed strategies for passive environmental modulation and their updating, it will be necessary to develop the material constituents of a dynamic exchange not in isolation, but rather as a condition of energy exchange and environmental modulation. This implies drawing on analytical methods that are available, but not necessarily used in the design process. These might include thermal imaging, digital analysis of environmental conditions, analysis of material behaviour and so on as critical design parameters rather than post-rationalisation and post-optimisation.

If we return to the two alternatives, the hermetic space and homogenous interior climate of air-conditioned boxes or the porous heterogeneous space of energetic exchange, it would seem odd that the preference should remain with the reductivism of the former. One feels reminded of that scene in Douglas Adams’ *Hitchhiker’s Guide to the Galaxy* where one character feels locked out from the world when he is in his house. Consequentially he decides to turn his house inside out in order to live in the world. The joke is of course on the self-imposed and artificial dichotomy between interior and exterior. This turning on the heating when it is nippy and the air-con when it is too hot and humid is a joke on all of us. Jolly good!

Notes

2. Ibid.
4. See the article on Material Performance in this issue.

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The Membrane Array Canopy, designed and constructed by the Emergent Technologies and Design masters programme in collaboration with structural engineers Buro Happold in 2007 at the Architectural Association, provides a porous canopy that grant views and a substantial reduction of horizontal loads while providing shade and protection from rain.

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The Revan Kiosk in the Topkapi Palace in Istanbul, Turkey, shows passive cooling strategies similar to the vernacular example in Abyaneh in Iran. The deep open recess on the first floor acts as a shade for the two-storey-high facade. The door on the first floor is shaded by a smaller roof that shades the lower area at lower sun-angles and accelerates the airflow to and from the interior, depending on wind direction.

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This traditional building in the famous historic village of Abyaneh, one of the oldest in Iran, is made from the typical red clay of the region. The elevation shows a number of passive environmental modulation strategies: the use of thick clay walls, with deep setbacks on the groundfloor to shade to window areas, as well as on the first floor, shaded by a wide overhanging roof. All openings have simple screenwalls that enable ventilation while protecting the interior from visual penetration. In this vernacular example, building elements and spatial arrangements operate in synergy and are likely complemented by the migratory pattern of habitation in response to temperature changes at different times of the day and different seasons. This tradition building in the famous historic village of Abyaneh, one of the oldest in Iran, is made from the typical red clay of the region. The elevation shows a number of passive environmental modulation strategies: the use of thick clay walls, with deep setbacks on the groundfloor to shade to window areas, as well as on the first floor, shaded by a wide overhanging roof. All openings have simple screenwalls that enable ventilation while protecting the interior from visual penetration. In this vernacular example, building elements and spatial arrangements operate in synergy and are likely complemented by the migratory pattern of habitation in response to temperature changes at different times of the day and different seasons.

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