THERMODYNAMIC ARCHITECTURE

[Low-Energy Tectonics and the Architectural Definition of the Ecological Envelope]

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Thermodynamic: 1. Of or relating to thermodynamics: physics that deals with the mechanical action or relations of heat. 2. Thermodynamic processes and phenomena.

Ecology: 1. A branch of science concerned with the interrelationship of organisms and their environments. 2. The totality or pattern of relations between organisms and their environment

Merriam Webster's Online Dictionary – http://www.merriam-webster.com

In the last decade, the use of the word sustainability has invaded all domains; it has been used alternately as a politic decoy to conceal less-than-altruistic intentions, as a tag to qualify the “goodness” of the architectural form or as a marketing strategy. However, the deeper impact of sustainability on architecture remains in doubt. In all of its forms, The Brundtland Report (UN, 1987), the document that first introduced the concept of sustainability in architecture and that implied a shift in the way architectural form is created, has barely affected the way architects proceed at a meaningful structural level. Nevertheless, the impact of sustainability and its consequences in the production of architecture seem to be reduced to the apparition of different systems of classification and eco-tagging (i.e LEED); sets of standards whose definition is an act of masked populism: they assure public recognition and success due to their sensitivity towards the environment despite implying a notion of ecology and technology only reachable for a reduced sector of society. Paradoxically, the so considered more “ecological” building is the one that less interacts and less is affected by the local conditions in which it operates. Buildings become volumes designed only according to external factors: economical interests, iconic ambition, etc., and later on, “plugged in” with all the services needed to fulfill the mentioned standards. The sustainable factor is not included in the design process except a posteriori.

The interest on the architectural definition of this field of operation lies precisely in the contradictions of its incorporation to the contemporary practice: trapped between the pressure of a continuously growing concern towards the environment, the political implications of its come into fashion and the wasted potentials of a genuine architectural revolution.
Thermodynamics is the physics that deals with the mechanical action or relations of heat and it is mainly based on four laws which describe universally reproducible phenomena of energy transfer. Due to these characteristics, the formulation of architecture in thermodynamic terms—as different contemporary critics and architects have already suggested\(^1\) — allows for a universal and scaleless multidisciplinary evaluation of the architectural form: it establishes a common platform for the construction of collective knowledge, one of the biggest potentials of the contemporary understanding of ecology. Moreover, it pictures architectural form as the precise combination of a set of ingredients that reproduces a physical process to achieve a certain effect in a given space.

In this context, architectural envelopes are imbued with a veritable political agenda that does not only rely on the simple proportion between its sides. Since form is only understandable as the ultimate definer of the relation between architecture and environment, most of the traditional constructions of the discipline (i.e. culture and history as meaningful operators) suffer from a chronic slightness, unbearable for those embodying architecture's autonomy. The role of the envelope needs to be adjusted accordingly: it is necessary to expand the notion of ecology and environment handled by architecture, to reconsider notions such as nature or artifice and, ultimately, to deeply question the tools that architects contribute to this discussion as a new politics of the envelope emerges. An approach based on the reformulation of the relation between the seasonal stability of the spaces, the exchanges with the environment, the very notion of comfort, etc., considering that a new form of habitat can emerge by exploring this new relation between architecture environment and energy\(^2\).

This relation between environment, envelope, use and form occurs naturally in many examples of passive architecture (based on low-energy technologies, orientation or dimensions). However, these examples have traditionally been perceived as non-desirable or uncanny, either bucolic imitations of a picturesque past or too predictable examples of the deterministic climate-conscious architecture. Still, their ingredients and the physical processes involved—when pictured in thermodynamic terms—form a sort of material recipe that can be mixed, combined and applied under similar climatic circumstances without recurring to their previous form. The basis of a formless, operative and productive theory of sustainable design applied to contemporary architecture.

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\(^1\) Inaki Ábalos and Samford Kwinter among others.

\(^2\) This particular understanding of the relation between architecture and environment has been formulated in many different ways, including works by Victor Olgyay, Otto Koenigsberger, Hassan Fathy or Philippe Rahm, and can be traced back to ancient times in the tropics.
LOW-ENERGY TECTONICS AND THE EVOLUTION OF THE GLOBAL CONCERN TO THE ENVIRONMENT

“[…] I think you have to adjust yourself to a reasonable price of crude. The era of a very cheap source of energy is gone and this is a new era. Now don’t expect the producers to accept something much below than what the market forces will indicate for their oil” […]”

Extract from an interview by Richard Kershaw of the BBC.

The globalized social presence of sustainability is the aftermath of a continuous evolution that implied multiple changes on its initial formulation and, ultimately, derived into a confusing amalgam of discourses, objectives, and ambitions with multiple intrinsic problems. Although nobody disputes its disturbing diagnosis of the global environment, the scope and relevance of its dictates still remains unclear nowadays. In spite of the lack of precision on its definition, sustainability has acquired an status of universal doctrine and, therefore, the construction of ecology as an architectural (cultural) product has been imbued with a populist character that overrides any possibility of transcending this new globalized agenda.

At present, it exists a great disconnection between architectural design and sustainable development which can be easily pictured by looking at its consequences as a caricatured portrait with two-faces: one, a technocratic monument to ecology (1), the second, a pastoral and remote praise of passiveness (2). The first one made of buildings designed according to external factors (economical interests, iconic ambition, etc.) and later on, plugged in with all the services needed to make them energetically efficient. The second, fully committed to the exploration of passive techniques but with a disturbing lack of urban density and, therefore, with no chances to have a real big scale impact. The result of this disconnection is a simulated version of a veritable political and architectural ecology; a sustained status-quo promoted by a restrictive understanding of technology, its means of production and a rejection of urbanity that compromises any capacity to transcend. Still, this situation of status-quo –an inherited condition since the apparition of modern movement and its post-modernist involution– had a potential turning-point with the oil and energetic crisis of the 70’s. This was an event that, for many experts on the field, signifies the globalization of the ecological concern.

4 Maniaque, C., Russell, H. ‘Sorry Out of Gas’
The crisis, motivated by a drastic raise of oil's price, generated a great controversy around the traditional way of life in the after war period—which relied enormously on an excessive energetic consumption. Since development was very closely related to the access to fossil energy sources and the world suddenly realized that those were not virtually endless anymore, it was necessary to develop –sustainable– alternatives questioning some of the deepest assumptions of that time. In this sense, outlining the origins and evolution of the concept is useful to frame historically the debate and understand its contemporary essential contradictions.

The origins of sustainability (and all its overused variants: green architecture, sustainable design, ecology, environmentalism, etc.) can be traced back to the development of the so called passive architecture. Most of the examples falling in this classification integrate form as a response to local climatic conditions as the awareness that buildings should be compatible with climate goes back to ancient times—gathered on codes, design manuals and rules of thumb of empirical origin, being the tropical regions particularly prolific\(^5\). This concern was relatively evident to many eighteenth-century European explorers who clearly documented the need of climate-sensitive design as a crucial feature to assure human health and well-being in these areas\(^6\). Somehow, colonial architecture could be read as the by-product of the adaptation of the European style of that time to a different climatic context.

\(^5\) Baweja, V.  
\(^6\) Emmanuel, R.
As a matter of fact, along with the increase of expansionist and colonialist ambitions, Western countries started to develop a more serious interest (and research) on these techniques due to their difficulties to build or guide building in tropical settings. Although new specialized educational programs appeared, such as the Architectural Association's Tropical Studies Program in London\textsuperscript{7}, and the word “design” started to be generally applied to some of these examples, the techniques were never considered as valid alternatives to the autonomous and abstract architecture promoted by the modern movement. At its most, they were portrayed as the pragmatic response to some of the urbanization and architectural problems derived from colonialism.

In this sense, 1987, the year of the apparition of the Brundtland report—the first institutional declaration including a definition of the word sustainability—had all the ingredients to become a new milestone in architectural history: a moment comparable to the apparition of reinforced concrete at the beginning of 20\textsuperscript{th} century or to the digital revolution in the 90s. However, in practical terms, it only meant the regulation and adaptation of the use of energy and carbon emissions involved in the construction and functioning of our buildings; a set of regulations gathered under different standards—the U.S. LEED certification is an example of those—that privilege a kind of building with almost no relation with its environment: waterproof, with a perfect thermal isolation and regulating every single exchange with the exterior. This contemporary definition of the ecological envelope implies a certain understanding of technology and ecology only reachable for a very reduced sector of society, and it is at the origin of numerous environmental inequalities. It presents the highest technology at the service of the status quo; after the crisis of the 70's, changing everything so everything stays the same.

This will to preserve an unvarying situation—an artificial and costly 'sustained' version of development based on a vast energetic consumption—together with the shift in the architectural discourse during the 1980s and 1990s (historic, cultural and social factors as shaping forces of architectural meaning) explain why the date has far less public recognition that any other major event in architectural history: its effects are not visible enough; it just affects technical management of the built environment.

The looseness of the institutional formulation of the problem and its later overuse are as evident as the aim of the manifesto: to highlight the potentials of the declaration by defining a neat field of architectural operation.

\textsuperscript{7} Otto Königsberger directed the Department of Tropical Studies at the Architectural Association from 1953 to 1971 when it was transferred to the University College of London under the name of Development Planning Unit. He worked at the DPU (still operative nowadays) until his death in 1978.
THERMODYNAMIC ARCHITECTURE OR THE ARCHITECTURAL DEFINITION OF THE ECOLOGICAL ENVELOPE

Envelope: 1. A flat usually paper container.
2. Something that encloses or enfolds completely with or as if with a covering.
3. A curve tangent to each of a family of curves or a surface tangent to each of a family of surfaces.
4. A conventionally accepted limit.

Merriam Webster's Online Dictionary – http://www.merriam-webster.com

The formulation of a thermodynamic theory on architecture implies the definition of a certain positioning in the relation between humans and environment as well as the questioning of certain assumptions such as the notion of contextualism, comfort or energetic efficiency. Nevertheless, it represents a political act of a very subversive potential that affects to our understanding of the architectural envelope –the architectural component that has traditionally assumed the role of regulating the exchanges with the exterior.

However, the idea of envelope in architecture –and, therefore, its attributions – has evolved during time influenced by both cultural and technological breakthroughs. For example, in classical architecture, the envelope performed as an structural element, as a demarcator of the limits between public and private, as the regulator of the exchanges with the exterior but also as the external expression of the interior space. With the time, this direct relation between interior and exterior was distorted: sometimes for constructive reasons (such as it is the case of Brunelleschi’s Duomo in Firenze) but sometimes also for aesthetic or symbolic purposes.

Agrippa’s Pantheon - Publius Aelius Hadrianus (Rome, Italy)        Firenze Duomo – Philippo Brunelleschi (Firenze, Italy)
Furthermore, this evolution gradually liberated the envelope of some of its initial duties (structural, waterproofing, etc.) and its facial condition started to gain relevance. On its new condition—with no need of faithfully replicate the interior of the building nor constrain its expression due to structural requirements—its role as a transmitter becomes preponderant. As a matter of fact, this sway will continue to increase with the layering of the envelope and the apparition of new materials that, in intermediate states, assure the conditioning of the interior space. The envelope is again liberated of one of its original functions: mediating with the environment. Since the insulation and waterproofing is now assured by other element the envelope becomes a virtually bi-dimensional element—a screen—depleted of any environmentally operative role.

This apparently innocent process is at the core of the already mentioned disconnection between architecture and sustainability. Nowadays, the relation between architecture and environment is deeply regulated by standards such as LEED that allow sustainability to function merely as an “add-on” to more or less traditional design outcomes, without affecting the core of a design. However, we can imagine an alternate relation between environment, use and form—one in which form and use follow climate.

Most of the so called 'sustainable passive techniques' already integrate this closer relation, offering an identifiable combination of elements and thermodynamic processes that produce a certain effect on a given space. If a certain passive solution is meant to be a precise response to local climatic conditions, then, this could be exported within a zone of areas with equivalent climatic conditions to produce similar effects. In order to identify the common zones where interchangeability is possible, we must establish a sort of “common tectonic market.” The Köppen-Geiger climatic classification offers one possible system: the world divided according to the combination of average annual and monthly temperatures and precipitation, and the seasonality of precipitation.

**LÆSØ HOUSES, DENMARK**

The material used for the thatched roofs is seaweed impregnated with salt which serves as insulation and waterproofing for the interior of the house while storing a large amount of rainfall.
The formal and material will vary but the environmental effect theoretically should be retained retained. Its operative essence will be constant while its cultural substratum changes according to local conditions.

Thermodynamics performs here a double role: on one hand, it serves as a common denominator for all the different agents involved with ecology since its principles are reduced to four simple laws of universal validity, they are easily understandable and applicable in different domains; on the other, it summarizes the potentials of reestablishing an environmentally active role to the architectural envelope and states the futility of discussing architectural form if not referred to a very precise strategical field of operation.

This field of operation (Thermodynamics) is what constitutes the substance of the architectural discourse related to sustainability: the real added value that architecture can offer as its contribution, that can be argued and discussed somehow independently of its architectural form. Otherwise, sustainable design and its potential political relevance are reduced to a superficial operation that disdains other extremely subversive elements. It simply relies on the facial condition of the envelope and its capacity to absorb the discourse of the moment. Architects are transformed into stylistic advisors, prisoners of the unbearable slightness of the architectural content that they have brought about.
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