A NEGENTROPIC VIEW OF COMPUTATIONAL MODELING

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Abstract. I propose a systemic view of computational modeling in architecture that is inspired by concepts in human ecology, information theory, and thermodynamics.

1. Introduction

1.1 MOTIVATION

Decisions regarding building design, construction, operation, and decommissioning affect in complex ways i) regional and urban patterns, ii) natural resources, iii) economic conditions, iv) building integrity, v) indoor environmental conditions, vi) human occupancy, as well as vii) social and cultural factors. Requirements of good practice alone suggest that such decisions be carefully scrutinized, let alone the aggravating circumstances of world-wide deteriorating eco-system integrity and the critically "asymmetrical" and unstable global economy. Theoretically, predictive computational modeling of events that occur within or are related to the building delivery process may be useful in dealing with such complexity and in supporting a more informed mode of decision making. In practice, however, this potential still appears to be widely untapped. This, I believe, necessitates above and beyond incremental improvements in the nature and functionality of modeling methods and tools, a broader phenomenological reassessment of the need for and role of computational modeling in the making of the built environment.

1.2. LIMITATION

Despite this rather broadly defined motivation, I will not address in detail matters outside the immediate realm of modeling. This limitation of scope is admittedly not insignificant. The availability of effective and versatile modeling tools may be a necessary condition for their pervasive use in the practice, but it is not a sufficient condition. In many instances, the fact that modeling tools are not used has little to do with their inherent shortcomings,
but is due to a professional context which offers little incentive for intellectual and monetary investment in predictive modeling activity directed toward improving the performance of buildings. Persistent provision of such incentives depends on a society’s overall commitment to the quality and sustainability of its built environment. However, once this commitment is made (a fictional scenario at the present time), the quality and systematic use of modeling methods and tools can make a difference.

2. Human Ecology and Design

2.1. A DEFINITION

It appears to me that computational building performance modeling as a paradigm is not indifferent to various views of design activity. In the narrow sense, it obviously presupposes a requirement-oriented approach to the formulation of a design task. In a broader sense, it is closely related to a human ecological understanding of design as an integral part of the totality of (largely regulatory) operations initiated by human beings as they interact with their surrounding world. The vital concepts for the understanding of these interactions are human beings’ ecological potency (e.p.) and the surrounding world’s ecological valency (e.v.) (Knötzig 1992, Mahdavi 1988). Put in simple terms, the former term refers to a dynamic human repertoire of capabilities and means of dealing with the world, while the latter term denotes the totality of that world’s characteristics as it relates to or accommodates such repertoire. This being established, a provisional definition of a modeling-relevant view of design is possible: Viewed as a process, designing (in the context of the built environment) involves the generation of formal/spatial entities and their organizational and (both "real" and "symbolic") functional patterns, physical/material specifications, and operational regimes with the (a priori expressed or a posteriori deducible) intention of favorably influencing the relationship between the ecological potency (e.p.) of human beings and the ecological valency (e.v.) of their surrounding world.

2.2. NOTES ON THE DEFINITION

i) What is implied here, namely to view the e.p.-e.v. gradient as the main driving force behind building activity, would be immune to the behaviorist error, as long as the autonomous instances and the dynamism of the poles human beings and surrounding world are recognized and considered. I have not implied that the design activity is caused by a perceived imbalance in the e.p.-e.v. relationship quasi in the way "response" would follow "stimulus".
ii) My suggestion to understand design in the context of means and actions to "favorably affect the e.p.-e.v. relationship" may be considered too narrow or even deterministic, particularly if the desired outcome in that relationship is falsely understood to be a static equilibrium. Given the above mentioned dynamism, equilibrium itself is paradoxically a transient state that is constantly reassessed due to continuous changes in e.p., e.v., or both. Furthermore, positive experiential qualities associated with some non-equilibrium transitional states may themselves be accommodated in designs, as a class of desirable e.p.-e.v. relationships.

iii) Given the above view, building activity is proactive: It goes far beyond the realization of a reflexive individual activity model to temporarily improve the e.p.-e.v. relationship. Rather, it involves considerable modifications to the surrounding world, so that its transformed e.v. can provide a better long-term match to the e.p. of the inhabitants. Close feed-back loops known from general biology may explain in principle the emergence of habitat patterns which in fact facilitate an improved e.p.-e.v. relationship (Mahdavi 1989).

iv) The environmental relationships in the above definition are understood to have both a material-energetic aspect, and an informatory aspect. The importance of this latter aspect is often ignored, although its role in people's evaluation of the built environment is often decisive.

3. Modeling And Design

3.1. MAPPING AND META-MAPPING

All living beings appear to make use of a "mapping" process to capture the salient features of their surrounding world in terms of a "model environment". While this model is often thought to be representative of the world's "actuality", it is nonetheless, in its specific manifestation, dependent on the individual's experiential background and intentional state. It is, as suggested before, the critical tension between this model environment and the individual's needs and desires that provides the context for the emergence of a "model activity" toward an organized enactment of regulatory operations. If we consider meta-mapping as a specificum humanum capability to map the primary mapping process (Knöting 1992, Bateson 1972), it is not difficult to see how, in the case of human beings, "model activity" can increasingly involve elaborate interventions in the surrounding world, e.g. via designing and constructing buildings. Thus, designing involves modeling in a two-fold sense: as a communicative representation of a desired "model environment" and as a procedural "model activity" toward its realization.
3.2 COMPLEXITY AND THE ETHICS OF MODELING

If the view that I have suggested is valid, then modeling is phenomenologically inherent to the design activity and introduces, as such, no paradigmatic novelty in design discourse. Historically, however, the continuously growing ecological potency of the human population and its transformational implications for the ecological valency of the planet’s sensitive ecological systems places an urgency on the relevance and importance of predictive modeling for designing.

The evolutionary development of building activity has not only lead to a successive reduction in the level of human exertion and continued increase in the potential for creating and maintaining artificially controlled indoor environments, but has also dramatically increased the frequency and severity of interventions in the surrounding context. In the architectural domain tendencies toward more control over "environment" have been increasingly realized through the use of energy-intensive building service technologies (Mahdavi 1996a). This "industry-based" approach to creating thermal comfort can be seen as the continuation of the efforts toward the reduction of "man’s dependence on thermal surroundings" (Fanger 1970) while further reducing the need for human exertion (Banham 1969). The price paid for this increased control has been a de facto increase in the exploitation of non-renewable fossil fuels and the corresponding environmental impact. In cybernetic terms, the industrial approach has been able to increase selectively the negentropy (negative entropy, cp. Brillouin 1956) in the sub-system human habitat (e.g. through maintaining indoor-outdoor temperature gradients even under extreme climatic conditions). However, this has been achieved by an accelerated entropy increase in the encompassing system that includes human habitats, namely the whole planet.

Recent history does not provide us with many examples of exercised restraint or hesitancy by human populations regarding the full application of their technologically augmented ecological potency toward a radical (and often detrimental) transformation of their surroundings. There is no evidence that any amount of predictive modeling per se would alter the pathology of this circumstance. However, while modeling as a technique may be value-neutral, its relationship to decision making is of ethical relevance: As an activity, modeling can support the exploration of design alternatives and thus at least partially eliminate excuses on the basis of ignorance for pursuing destructive interventions.

3.3. ON THE COGNITIVE FUNCTION OF MODELING

I have emphasized the critical functionality of modeling toward a better understanding of the multi-faceted implications of design interventions in a
complex systems. The key word is "understanding", as in fact, historically, models have quasi acted as an interface between system complexity and human cognition. However, modeling has been seen to achieve this through "reduction". Lévi-Strauss introduced his reflections on the topic of the arts referring to women portraits by Clouet whose paintings show a tendency toward reduction similar to "Japanese gardens, matchbox cars, ships in bottles" (Lévi-Strauss 1981). What is implied here is that, at an abstract level, the "reduced model" may be seen per se as a general paradigm for objects of art. Even 1:1 scale models involve reductionist features as certain dimensions of the modeled object (such as volume in paintings, color in sculptures, and the time dimension in both) are not represented. In a sense, one could argue that even gigantic architectural structures of ancient cultures can be viewed as reduced models as they, at least in certain cases, were meant to represent or refer to entities of mythical and cosmic dimensions. Lévi-Strauss suggests that the significance of reductionist modeling stems in a sense from the reversal of the cognition process. As opposed to the analytical process, reductionist modeling involves the cognition of the whole prior to the cognition of the elements whereby the totality of the object appears easier to grasp and less intimidating. This view warrants some observations:

i) Strategic reduction (or reorganization) of data (e.g. in terms of recognition of trends and patterns) is a hallmark of the scientific approach toward model development. Such reduction, if performed carefully, is not only permissible, but also necessary. Reductionism, however, is problematic, as it is commonly understood to involve the elimination of salient system parameters. Obviously, there is not always a clear demarcation between the two, as in many instances, the identification of a salient system parameter depends on the state of general knowledge in the relevant domain.

ii) Not only symbolic information processing but also analytical (and even numeric) methods have been criticized as unfit to capture the behavior of highly complex systems. Connectionist models have been suggested as alternatives (cp. a pertinent review in Dreyfus and Dreyfus 1988). However, as far as the architectural applications of computational modeling are considered, I do not consider a polarized debate about the virtues and shortcomings of these approaches to be particularly fruitful: we are not even close to a full utilization of the potential of analytical and numeric means in representation of system complexities. Furthermore, such means, as compared to connectionist approaches, may be more effective in facilitating a closed modeling-to-design feed-back loop, as their predictive potency is, at least in principle, transparent to design reasoning.

iii) If symbolic, analytical, numeric, or connectionist, there will always be a remaining uncertainty in the validity of modeling-based predictive statements. Based on prior human ecological groundwork, I have proposed
an adaptive-iterative approach toward design interventions in socially and ecologically sensitive contexts (Mahdavi 1988). This approach involves the incremental (multi-stage) realization of the design intention accompanied by modeling, monitoring, and evaluation activity to judge the design effects at every stage, and to accommodate necessary adaptations and timely course corrections based on the acquired feed-back.

3.4. MODELING IN ARCHITECTURE

Modeling has a long tradition in the architectural design process. From physical scale models to advanced virtual reality representations, architects have always used various media to "externalize" design ideas. The modeling purpose has not only been to communicate the properties of designs with owners, contractors, and constructors, but also and primarily to dynamically support iterative design processes by triggering a dialogue between the designer and partial design solutions. Models help support this dialogical process in many ways. They allow certain features of design to be emphasized, isolated, and thus more closely studied. Furthermore, a large number of parametric operations (variations, alterations, comparisons) that would not be possible on real artifacts can be effectively performed on models.

3.5. THE SIGNIFICANCE OF COMPUTATIONAL PERFORMANCE SIMULATION

Historically, the main concern of architectural modeling has been visual appearance and constructability (dimensions, structure, spatial relationships, massing, color and materials). However, the increasing complexity of building technologies and growing awareness of the need for environmental conservation and habitability have led to a broader view of architecture modeling to cover other aspects of buildings such as their performance in terms of energy consumption and thermal, lighting and acoustic quality (Mahdavi 1996b). Consider the complex pattern of parameters which influence building performance in just one domain. For example, the energy consumption of buildings is influenced by formal variables (building geometry, massing, orientation, etc.), "semantic" (attributive) variables (e.g., properties of materials such as density, thermal conductivity, specific heat, thermal and solar emittance, absorptance, transmittance, and reflectance), and contextual properties (such as micro-climatic conditions). Performance simulation tools allow one to parametrically analyze and predict the complex interaction-patterns involving these variables.

The situation becomes even more complex, if we consider a) the interrelationships of various performance domains (involving potential goal conflicts) and b) the fact that the energy conservation as a paradigm is being
replaced by a more comprehensive view of ecological sustainability. Given this circumstance, few would disagree that it is necessary to critically review design decisions in advance, and few would question that such review can (and must) be supported by computational modeling. Such modeling would allow one, in principle, to evaluate "real" experiments and operations (e.g., construction of buildings, infrastructures, traffic systems, industrial facilities, etc.) before they are performed, by replacing them with computationally conducted "virtual" experiments and operations.

3.6. THE NEED

I have depicted modeling as an integral part of designing the built environment. I have argued that if the relationship between ecological potency and ecological valency is to maintain an appropriate balance, the technologically augmented ecological potency of human beings in transforming the world must be accompanied by a commensurably augmented cognitive potency in long-term modeling of the effects of such transformations. This view implies a program that the current state of affairs in modeling (developmental theory, application culture, regulatory framework, etc.) does not accommodate. We need an improved theoretical frame-work for modeling, better and integrated computational modeling tools, and a more coherent strategy for using them.

4. Entropy, Negentropy, and Modeling

4.1. SYSTEM ELEMENTS AND BOUNDARIES

Given the previous discussion, the basic structure of the problem may be thought as involving three pertinent systems, i.e., System 1: environment, System 2: built structures, and System 3: inhabitants. A discourse of modeling may address these poles at various strategic levels of observation, and the boundaries of the system elements may be defined in various scales, from narrow to broad. Typically, if applied at all, conventional modeling practice tends to a radically limited view of each element: Environment is often only a "site", built entities are seen only in their individuality and devoid of an infrastructural context, and inhabitants' needs are considered only in as far as they are represented in code-type minimum requirements.

4.2. OBJECTIVE FUNCTION

The broad nature of an alternative negentropic view of computational modeling in the building domain is reflected in a definition of the objective
function of building activity as one that is geared toward provision of desirable occupancy conditions while reducing (ideally eliminating) negative ecological impact (Mahdavi and Ries 1997). Provision of desirable occupancy conditions corresponds to the previously discussed relationship between the inhabitants' ecological potency and the habitat's ecological valency. But facilitating the potential for a better match in this relationship is only one part of the equation. To satisfy our definition of the objective function, it must be done in a "sustainable" manner, that is with a meaningfully reduced rate of entropy increase in a broadly defined System environment.

The components of the proposed objective function may be conceptually expressed in entropy terms: While the quality of occupancy in view of provision of comfort, flexibility, control, and informational quality may be ordered on a negentropic scale, the environmental impact of buildings may be captured in terms of associated entropy increase in the relevant environmental system. This yields, in a first approximation:

\[
\text{maximize } \Psi, \quad \text{with } \Psi = \Delta N \Delta S^{-1}
\]

where \(\Delta N\) is the negentropy increase relevant to the inhabitants and \(\Delta S\) is the resultant overall effective entropy increase due to an intervention (i.e. building activity). Obviously, the operationalization of the above function involves major difficulties: measures of environmental impact are non-trivial and may vary according to the evaluation time horizons considered. The definition of occupancy quality is no less complex as generally agreed upon indicators are difficult to identify. Nonetheless, I submit that a good understanding of this correspondence is of essential importance, even if it is "merely" conceptual. Below I will discuss research directions likely to provide evidence for the operational relevance of the proposed negentropic view.

4.3. ENERGY AND BEYOND

Energy simulation programs have been around for quite a long time. Computational estimation of building energy use is one of the most common applications of performance simulation tools in the architectural domain. The conceptual framework that I propose, not only allows for the incorporation of energy use in a negentropic interpretation, but it also points to the limitations of energy use indicators as a exclusive performance criteria. Obviously, the use of building energy systems allows one to maintain target space temperatures (and other indoor environmental parameters) over long periods of time even under extreme outdoor conditions. Needless to say, this local increase in negentropy is accompanied by an even larger entropy increase in the encompassing system that includes both the habitat and its
environmental context, as in the process typically non-renewable energy resources are depleted, waste heat is generated, and pollutants are introduced into air, land, and water. In a sense, the entropy increase may be interpreted as corresponding to the "investment" that would be required to reverse the impacts of the intervention.

In the past, building construction and operation practices have not been concerned with setting up entropy-relevant balance equations to evaluate alternative means and approaches for indoor environmental conditioning. One should not forget that the emergence of energy use in the early seventies as one of the indicators of a buildings' quality (or lack thereof) was principally attributable to economic forces (abrupt rise in energy prices) rather than environmental concerns. Only recently a consensus has emerged suggesting that energy consumption alone is not a sufficient criteria for the evaluation of the thermal quality. Although energy requirement indicators reflect to a certain degree one aspect of the resource depletion due to building activity, they fall short of representing the complex pattern of environmental impacts caused by the construction, operation, and decommissioning of buildings. This insight has led to increased activities in various quarters toward the development of more comprehensive indicators of environmental sustainability.

4.4. EMERGENCE OF ECO-ANALYSIS

There have been many recent efforts to apply comprehensive life-cycle assessment (LCA) methods toward representation and evaluation of the environmental implications (energy use, depletion of resources, environmental emissions, degradation of landscapes, etc.). However, the majority of these efforts still do not comprehensively address of the multiple phases of buildings' life, i.e. design and construction, operation, and decommissioning (Allen et al. 1996, Etterlin et al. 1992, Fava et al. 1991, Goedkoop 1995, Graedel and Allenby 1995, Lippiatt and Norris 1995, Little 1995, Mahdavi and Ries 1997, 1996). Despite their potential toward comprehensive environmental evaluation of building designs, LCA tools have certain limitations (cp. Mahdavi and Ries 1997): a) LCA's are data-intensive, and therefore require considerable time and effort to prepare; b) reliable and adequate data may not be available, c) results from the analysis may require an expert interpretation; d) aggregation of impact categories toward unified indicators may be problematical; e) the pertinence of LCA's results depends to a large extent on a comprehensive definition of the "balance domain".

It is not difficult to see that computational modeling in general and a negentropic framework in particular can alleviate some of these problems:

i) Computational tools obviously cannot generate specific data such as the embodied energy of materials and the environmental emissions associated
with building processes. Although application of means such as neural nets and fuzzy logic may allow one to a certain extent to utilize sporadic and ill-structured data (Menzel et al. 1997). More important is however, the role of computational potency in dealing with the inherent complexity of the building process and the extent of data necessary to model the effects of the inter-related agents involved in the process. However, there is no realistic possibility of incorporating LCA in an ideally iterative design and evaluation process without the seamless integration of computational LCA tools in the overall design environment (Mahdavi 1996b, Mahdavi and Ries 1996).

ii) Though very different in their scope, domain, objectives, and tools, most LCA methods attempt to accomplish a two-fold aggregation: a) an aggregation of multiple environmental impact measures into a small group of indicators (occasionally into only one super-indicator); b) an aggregation of multiple environmental impacts over a certain time horizon. It appears to me that most LCA methods attempt to accomplish this two-fold aggregation via means that display a negentropic "touch", even though they neither entail an explicit reference to a negentropic terminological framework, nor do they provide for a coherent operationalization of entropy as an eco-indicator.

Let me briefly dwell on the latter point using the example of the Eco-balance method (Etterlin et al. 1992). This method groups the basis data into energy consumption (in MJ·kg⁻¹ of material) as well as loads to water, air, and land (in m³·kg⁻¹ of material). The key operation is the conversion of loads to the air and water from units which represent pollutant volume, into a unit which expresses the Critical Volume ($V_\text{c}$) of air or water which would be contaminated to its legal threshold limit by the pollutant:

$$V_\text{c} = E \cdot T^{-1}$$  \hspace{1cm} (2),

where $E$ is the actual volumetric emission of the pollutant and $T$ represents the legislated legal threshold limit for the pollutant. The quasi entropic nature of critical volume is evident, as it represents a measure of dilution (contamination, dispersion) or increase in entropy.

Obviously, there is still a long way from simple measures such as critical volume or eco-factors to a more comprehensive and coherent entropy-based eco-indicator. Nonetheless, it does appear to be reasonable to assume that a comprehensive and computationally supported eco-analysis strategy, if substantially refined and enhanced, may facilitate a sufficiently detailed evaluation of the second term of equation 1 ($\Delta S$), i.e., the entropic implications of architectural interventions. There is no question, however, that the approximation of the occupancy-related first term of this equation ($\Delta N$) involves no less challenging difficulties.
4.5. A DIFFERENCE-MAKING DIFFERENCE

Previously, I interpreted building activity as in intervention in the surrounding world with the aim of positively affecting the e.p.-e.v. relationship. Obviously, this intervention has entropic implications, as expressed by the second term of equation 1. However, the degree of actual entropy increase does not necessarily correlate with the resulting "habitability", i.e. occupancy-relevant quality of the built environment in view of provision of comfort, flexibility, control, and informational quality. It has been frequently argued that a building with a high energy consumption rate does not necessarily provide a higher degree of thermal and visual comfort. (In fact, some have even suggested a negative correlation.) This is part of the reason why I propose to evaluate such occupancy-relevant qualities on a separate negentropic "habitability" scale (cp. the first term of equation 1).

How do we generally go about evaluating habitability? Three programs readily come to mind:

i) The prescriptive program involves the quasi lexicological definition of minimum requirements regarding the constitutive building elements, components, and systems and their relationships. The idea is that meeting such requirements would warrant habitability.

ii) The performance program implies the definition of target performance criteria together with their attributes. The idea is that a building's habitability can be evaluated by measuring its behavior against the target performance criteria.

iii) The flexibility program suggests that given variations in occupants' ecological potency, buildings' habitability should not be linked with meeting any rigid set of performance criteria. Rather, the idea is to measure the habitability in terms of buildings' capability to accommodate a wide range of spatially and temporary variable environmental expectations.

Put in provocatively simple terms, all programs suggest one has to do $\alpha$ if one wants to achieve $\beta$. However, the prescriptive program defines $\alpha$ and not $\beta$, the performance program defines $\beta$ but not $\alpha$, and the flexibility program defines neither $\alpha$ nor $\beta$ (although it sometimes defines performance variables without specific target attributes).

But what sources of information lead to the definition of attributes for $\beta$-type parameter? Typically, psycho-physical correlations have been the prime candidate. Thermal comfort research exemplified this point par excellence, as successive efforts have been made to correlate certain measurable environmental and personal variables (such as indoor air and radiant temperatures, air speed and relative humidity, clothing and activity, etc.) with occupancy reports on thermal sensation as expressed via a standardized psycho-physical scale (Mahdavi 1996a). These efforts have typically relied on both physical and physiological models and statistically systematized
observations. If, in fact, clear and measurable performance variables and associated (desirable) attributes can be established, then we should be able to work out the basis for a negentropic formulation of habitability: We expect a "well-tempered" indoor environment to be in a specific behavioral state among a very large number of possible behavioral states. In this context it does not matter if the performance program is considered or the flexibility program. While in the former case, the assumption is that the desired state is known a priori, in the latter case it is continuously reestablished based on occupancy feedback: a building that offers the possibility for ad libitum realization of a large number of indoor environmental states, obviously ranks high on a negentropic scale of habitability. (An essentially identical reasoning is sometimes used to define a key feature of "intelligent" buildings. It implies that a building should be considered as more intelligent, if it allows occupants to individually adjust their immediate environment according to their preferences. Micro-zoning as applied to HVAC and lighting systems and the so-called user-based environmental conditioning systems are examples of methods and technologies toward facilitating such adaptability.)

But matters are more complicated. A major problem lies in the fact the psycho-physical scales are notoriously debatable. An increasing number of researchers would agree that it is highly problematic to postulate a deterministic relationship between measurable environmental factors and occupants' evaluation of environmental conditions (Mahdavi 1996a). To systematically elaborate on this point, we need a suitable terminology. I propose the human ecological definition of material-energetic and informatory aspects of the environmental relationships (Knötzig 1992, Mahdavi 1996c, 1992, 1988). The idea is that the occupancy evaluation process involves both the material-energetic (e.g. sound levels, CO₂ concentrations) and the informatory (e.g. recognizable acoustical patterns, associative characteristics of fresh air) aspects of the relationships between inhabitants and the built environment. In a nutshell, it appears that human evaluation processes are generally easier to describe and predict in exposure situations dominated by the material-energetic aspect of the environmental relationships. In extreme cases of high-intensity exposure, the necessity for protective regulations is self-evident due to the obvious health hazards for the involved individuals. It is, thus, not surprising that most efforts toward predicting the outcome of human evaluation processes have focused on the identification of a measurable material-energetic scale (such as sound pressure level) to which subjective judgments (such as the degree of annoyance) are expected to correlate.

The derivation of statistically relevant relationships between material-energetic stressors and psycho-physically expressed occupancy evaluation has, despite its obvious practical advantages, certain shortcomings. A central
problem lies in the notorious negligence of the informatory aspect of the environmental relationships which may be decisive even in extreme energetic exposure conditions. Sound levels of around 100 dB apparently do not hinder a positive evaluation of the acoustical environment in a discotheque’s dance area, nor does the extreme low sound level of droplets falling from a faucet hinder a very negative reaction by a person in need of sleep. Likewise, it is an empirical fact that there are inter-individual variations in the evaluation of a shared thermal environment. Furthermore, it appears that as the informatory aspect of an environmental relationship becomes more dominant, the inhabitants’ evaluation becomes less predictable. As a result, prediction of inhabitants’ evaluation of exposure situations in circumstances where the individual information processing plays a decisive role has been and remains an extremely difficult task. Information theory provides a basis for a "content-neutral" quantification of information via utilization of the negentropy concept. From thermodynamics, we know that the knowledge of the microscopic state of a system is inversely proportional to its entropy, i.e., information may be interpreted as negative entropy or negentropy. However, in measuring the semantic component of information, we would have to achieve the near impossible goal of fully understanding the deep structure of human information processing including the inter-individual differences in contextual, experiential, and associative conditions of perception and evaluation processes. This does not mean, however, that the cumulative experiences in the architectural design community and scientific research in this area (particularly in human ecology, cognitive psychology, and experimental sociology) have not provided us with some reliable clues as to the scope of the necessary environmental conditions (including the required levels of flexibility and adaptability) for positive occupancy evaluation. While a negentropic formulation based on such clues may not radically eliminate the shortcomings and inconsistencies in the current building evaluation processes, it is likely to add conceptual transparency and coherence to procedures that establish modeling needs and scope, generate simulated data, and interpret the results toward aggregate judgments.

6. Concluding Remark

The search for a coherent conceptual underpinning of computational modeling in architecture should not be mistakenly seen as a mere discursive fancy. Building activity in its broadest sense, involves system interventions of colossal scale, yet it is routinely based on poorly informed decision-making processes. In few other areas of human endeavor would such sparsely occupied informational matrices lead to aggregate decisions of such significant impact. A piecemeal approach to improving the informational basis of architectural decision-making via computational
modeling is not likely to essentially change the unsatisfactory nature of the status quo. I submit that the proposed negentropic view can provide the conceptual coherency and depth needed to match the multi-faceted and extremely complex profile of architectural interventions in view of their implications for environment and habitability.

References


