A teleonomic distributed cognition approach to architectural design

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Abstract

The purpose of this article is to explore a newly defined concept of distributed cognition in a spatial domain and to propose how this conceptualization may be applied to how architectural space is organized. A novel view of distributed cognition is presented, which is concerned with the purposive behaviour of an organism-in-its-environment. We term this concept teleonomic distributed cognition. Teleonomic distributed cognition is the ability of an organism (including humans) to interact with its environment for the purpose of satisfying its physiological (internal and external) and social needs in order to survive and sustain itself. An implication of this approach is that the sensory capabilities that drive the teleonomic distributed cognition of the organism define its spatial domain.

Keywords

distributed cognition
spatial organization
configuration
agency
spatial intelligence
Teleonomy

Introduction

Architecture is intrinsically concerned with understanding and articulating spatial scenarios in order to improve or invent solutions for enhancing a given scenario to enrich the built environment, and consequently, human existence. However, architectural practice tends to rely on methods that tend to flatten spatial problems into something quantifiable so that they can be managed and planned. There is often a qualitative disconnect between the articulation of spatiality in the built environment and the spatiality of being. The issue of space is fundamental to the practice of architecture because people, society, space and environment are inexplicably linked. Human beings are intrinsically manipulators of their environment and are coupled to the world through their capacity to sense. The capacity to sense is the ability to distinguish differences in the environment that make a difference to us (Uexküll 1957; Bateson 2000). Our sense-making capacities allow us access to, to interact with and to act in our environment. This article proposes a teleonomic distributed cognition approach to architectural design and outlines an approach to configuring architectural space on the premise that the conception of space, and the manner in which architects conceive of spatial organization, should be grounded in biological origins.

Naturalizing space

The idea of space only appeared in architectural discourse in the late nineteenth century when it became important in two ways: first as the embodiment of human activity inside the architectural form and second it became aligned to aesthetic ideas in an attempt to define beauty. The German art historian August Schmarsow extended the latter notion proclaiming space to be the essence of architecture, as an art (Schwarzer 1991). The issue of space whence became a central topic in

architectural discourse, leaving the realm of non-consideration and evolving towards consideration of space as an abstract concept. As such, space has achieved a hold on architectural thought due to the rise of the ‘intellectual’ architect, who seeks to expose the ‘nature’ of architecture and claim the high ground. Louis Kahn (one of the most influential architects of the twentieth century) claimed ‘space’ to be essential to the continual renewal of architecture, stating ‘architecture is the thoughtful making of spaces. The continual renewal of architecture comes from changing concepts of space’ (in Ven 1987: xi).

Whilst the origin of space in architectural discourse is occupied with sensorial engagement with the environment the idea was transcribed from C19th scientific theories of vision concerned with how the mind and senses grasp three-dimensional forms and space. The ocular-centric focus thus promoted vision above the other senses, thereby objectifying space. Ever since classical science ‘mathematized’ space there has been an inclination to redefine what we understand space to be, to break its objectification and to tie space to being-in-the-world. We propose that in order to understand space we need to define its biological origins because space is a property of living things and of being in the world.

The notion that space is intrinsic to being is acknowledgement of space as sensorial. Space is intrinsic to being, and essentially behavioural, effected through the capacity to interpret a difference. Our activities (or behaviour) are what effected the organization of built space since humankind first progressed from congregating around fire. In this respect, the psychologist, architect and design researcher Bryan Lawson remarks that architects ‘tend to consider space as an abstract concept and not a behavioural phenomenon, and yet paradoxically assume that behaviour will follow their predictions’ (2001: 200).

The significance of space even now is too often bypassed in architectural practice for aesthetic or commercial priorities. Architects tend to view space as an abstract concept and thus many built settings are ill-suited or ill-tuned to their inhabitants. However, these considerations are changing as acknowledgement exists that virtually everything a human is and does is associated with the experience of space. Anthropologist Edward T. Hall points out that our sense of space is a synthesis of many sensory inputs (visual, auditory, kinaesthetic, olfactory and thermal) constituting a complex system and that not only does each of our sensory apparatus constitute a complex system but that our experience is moulded and patterned by culture. He claims that there is no alternative but to conclude that people from different cultures live in different sensory worlds. Space is sensorial and 'one of the basic, underlying organizational systems for all living things – particularly for people' (Hall 1966: xii). Space needs, Hall states,

> may be as basic as the need for food. Not only does everything occur in a time-space plane (largely taken for granted), but the handling of space can be, and often is, a life and death matter for many organisms. (1963: 424)

Formalizing space

The French Marxist philosopher and sociologist Henri Lefebvre recognized the mental and physical aspects of space as intertwined and mediated through what he called spatial-practice, referring to habitual tendencies cast into the artefacts and structures that we inhabit. In other words, lived-space is the assimilation of physical and mental space. His 'code' expresses a tri-dialectic process whereby space is

created and creative effected through the relations between subjects, their space and surroundings, meaning that space is social because it unfolds through interaction. Frustrated with the Cartesian dichotomy, as ‘promoting the basic sophistry whereby the philosophico-epistemological notion of space is fetishized and the mental realm comes to envelop the social and physical ones’ (Lefebvre 1995: 5), Lefebvre sought to unify mental and physical space as mediating lived-space. Recognizing space reduced to a mental concept, he protests that the body is abstracted to ‘a simple mediation between subject and object’ as opposed to a practical, fleshy body ‘conceived of as a totality complete with spatial qualities’. As a social product, he states, ‘[s]pace is neither a “subject” nor an “object” but rather a social reality – that is to say, a set of relations and forms’ (Lefebvre 1995: 116). Emphasizing the social dimension of being in the world Lefebvre stresses that interaction is both mental and physical. ‘Space is social morphology: it is to lived experience what form itself is to the living organism, and just as intimately bound up with function and structure’ (Lefebvre 1995: 94).

Drawing on Lefebvre’s tri-dialectic structure we can articulate typical cognizing of space as distinguished by the mental, physical and lived. ‘Mental space’ is abstract, what may be termed ‘a-space’, and pertains to the concepts, theories and ideas articulating what we think about space and engagement in the world. ‘Physical space’ equates to the corporeal environment and its representation, with respect to geometry and significantly to interpretations based in mathematics and physics. Euclidean Space is the typical representation and means by which we come to be taught to think about space at school. We thus refer to Physical space in this article as ‘e-space’. Lived-space is social, equating to everyday life. It is the space of organismic interaction and the spatiality of the organism-in-its-environment. We thus

refer to lived-space in this article as ‘o-space’. ‘E-space’ is the geometrical representation of o-space, rooted in a particular notion of the world: i.e. a-space. Being a ‘science of form’ into which we cast our experience to represent the shapes and forms that we perceive to understand and scrutinize them, and communicate spatial scenarios to one another. O-space is space as lived, and as a mediation of mental and physical space, emerges as a result of the coupling between organism and environment. Human-space is a form of o-space, equating to the spatial intelligence of human beings. We thus determine ‘o-space’ to be a product of interpretation effected through a mapping between mental and physical space, which effects lived space resulting in action: a cyclic process perception-interpretation-action. Thus lived-space is affected by, and affects, the organism-in-its-environment, as depicted in Figure 1.

Figure 1: Lived-space is a mediation of the mental and physical dimensions of space.

Space as an enabling constraint

Everything in the physical everyday world is spatial and temporal, and through constraints is creative. The presence of something is productive because it affects something else. Affected through the ability to feel or perceive and affect the environment, lived-space is a (habitual) state of fluidity and perpetual readjustment articulated through an organism’s activity and interaction. We interact with the world through our senses, which define our spatial environment and which we use to ‘navigate’ said environment. This is a condition that emerges and fluctuates as a result of a perceiving entity’s interpretation (which is conditional on the entity’s state) of its surroundings and the effect of this impression on the environment: a cyclical

process of feedback between internal and external factors that coalesce to effect action (Uexküll 1926).

Space is organizational, in the sense that rudimentary constraints effect (through meaning) direction and distance in a relational sense. Space is experiential, and these factors are poly-dimensional. Being rudimentary the organizational properties are brute-facts, whereby actual existences and effects arise out of their relation to other things. The mediation of the experiential and organizational properties of space result in space as lived, being the regularities and habits of the organism-in-its-environment. Habitual tendencies are cast into the artefacts and structures that organisms create: what Lefebvre called ‘spatial practice’. ‘The spatial practice of a society secretes that society’s space; it propounds and presupposes it, in a dialectical interaction; it produces it slowly and surely as it masters and appropriates it’ (Lefebvre 1995: 38), resulting in what may be referred to as niches of habitation. Organized by purposeful activity, an organism’s niche is a habitual condition effected at one scale by differences across boundaries and scales of composition (Hoffmeyer 1998) and at another by differences to which the organism reacts and has intention towards (Uexküll 1926; Bateson 2000).

The spatial significance of the physiological and social needs of organisms equate to what the developmental psychologist Howard Gardner terms ‘spatial intelligence’ (2011). Our awareness of the events and things surrounding us stem from our cells that constitute our bodies and their ‘calculating’ capacities. The spatiality of an organism is affected through its capacity to sense, which underpins perception and capacity to engage with the world. This ability (stemming from our cells) is ambient and distributed. A living-cell is, fundamentally, a semiotic-niche, meaning that it must master a set of signs by which it can control – or maintain – itself (Hoffmeyer 1998),

and like all living things acts according to physiological and social needs. Having the capacity to distinguish self-from non-self a cell is, thus, a model of the ontology of 'self' (Weber 2009). The spatiality of an organism and its engagement with its surroundings may thus be extrapolated on the basis of cell/niche (inter)action – after all an organism is, at base, an ecosystem of cohabitating cell formations (Hoffmeyer 1996) – which may be established as pertaining to interactions (or behaviours) that, if not indifferent, are either positive or negative. Taking the basic unit of existence to be the organism-in-its-environment (the living-cell being the nascent form), which is coupled to the world through its capacity to sense, and thus interpreting its surroundings establishes a biological notion of space. The spatial intelligence of an organism is affected through its capacity to sense, which underpins discernment of the environment and capacity to engage with the world. This ability (stemming from our cells) is ambient and distributed, and from this perspective space is 'lived'. Effected through the ability to feel or perceive and affect the environment, space is a (habitual) state of fluidity and perpetual readjustment articulated through an organism's activity and interaction. 'Human-space' may be comprehended on the basis that we are an eco-system of cohabitating cells that are continually exchanging 'information' with their environment(s).[1] In short our senses couple us to the world and our perception of the world defines our environment, what Jacob von Uexküll (a biologist) refers to as Umwelten, which defines the functional space of an organism (Uexküll 1926, 1957). Our spatial awareness and the capacity to 'calculate' our environment is ambient: i.e. it is intrinsic to our being: see footnote 1. Architect Leon van Schaik argues that intelligence is a distributed system: not something held like a command centre in the brain and then distributed, but something that is present throughout the organism. Spatial intelligence underpins our ability to engage with the

world and to perform, and, as van Schaik stresses, must be accounted for in the buildings that we design. He claims that spatial intelligence is the most under-appreciated of the human intelligences because it is non-verbal, difficult to quantify and – using all of our senses – is more than visual. Spatial intelligence is early to be deployed, mastered as we learn to navigate in the world, and is soon relegated to our unconscious (Schaik 2008).

The teleonomic distributed cognition approach described below attempts to bridge the gap that still exists between the sensorial approach taken by Hall, the social dimension espoused by Lefebvre and Gardner's 'spatial intelligence' to the biological roots from which all human beings phylogenetically and ontogenetically evolved from.

Teleonomic distributed cognition: An ectoderm-centric perspective

The human organism may be viewed as ectoderm-centric because of its embryological development, i.e., after implantation in the uterus the fertilized oocyte develops into a multicellular human being. This process involves its transformation from a bi-laminar to a tri-laminar embryonic disc in the gastrulation process, which leads to the development of the human body form. The gastrulation process includes the formation of the primitive streak, development of the notochord and the differentiation of the three germ layers: the ectoderm, mesoderm and endoderm. This flat three-layer structure transforms into a three-dimensional structure that resembles a straw. The inner layer is the endoderm, the intermediate layer is the mesoderm and the outer layer is the ectoderm (Moore and Persaud 2003). The ectoderm develops into the epidermis including hair and nails, the central and peripheral nervous system and all of our senses. Thus the development of the ectoderm reveals a direct connection between our senses and the central nervous

system, the central nervous system being the in-turned portion of the external surface of the embryonic body. The development of this human organism begins from the time the sensory organs come online and start interacting with the surrounding environment, acquiring and processing stimuli from its inner and outer universe (Montagu 1978). Figure 2 shows this interaction where the autopoietic organism (Maturana and Varela 1987) or system engages recursively with the environment over time. This recursive engagement impacts both the autopoietic organism and the environment in a never-ending struggle, showing the ectoderm-centric nature of human existence. Note also that other human organisms may be viewed from the perspective of the sole autopoietic organism as just part of the surrounding environment (see Figure 3). Resulting in a teleonomic cognitive process that is consensual and distributive in nature, i.e., social; human organisms and the surrounding environment are part and parcel of the cognitive process, making memory and history an essential component of the cognitive horizon.

Figure 2: System-environment coupling (redrawn from Maturana and Varela 1987).

Thus, the embodiment of teleonomic distributed cognition in the human organism is a matter of biological phylogenetic and ontogenetic development. Also, the object(ive) of a human organism is primarily and ultimately its consciously or unconsciously determined physiological needs, whatever their scope might be defined to be. We are born with that object(ive), and it persists to our last breath. Thus, a working definition of teleonomic distributed cognition is: the ability of an organism to interact with its environment for the purpose of satisfying its physiological (internal and external) and social needs to survive and sustain itself (Cardenas-Garcia 2013)[2]. A teleonomic process or behaviour is one which owes its goal-directedness to the operation of a program, which “is (1) something material,

and (2) exists prior to the initiation of the teleonomic process. Hence, it is consistent with a causal explanation" (Mayr 1974). Similarly, scientist Addy Pross in What is Life? states 'Teleonomy, as a biological phenomenon, is empirically irrefutable […] all living things behave as if they have an agenda' (2012: 9).

An ectoderm-centric perspective of teleonomic distributed cognition serves to better understand how spatial intelligence, or the ability of an organism to interact with its environment (in space and time), is integral to being and is fundamental to experience, and emphasizes how organisms are capable of perceiving their environment only by means of their senses. Perception begins from the point our senses come into being. Our senses enable us to develop sensorial maps of our environment. A sensorial map is defined as a recognizable distribution of matter and/or energy that we can perceive. For example, in the case of touch these two- and three-dimensional sensorial maps occur all over our bodies because of the nature of our cutaneous sensors being deployed over areas of our skin. They might imply pressure, i.e., sharpness and bluntness; heat and/or cold; and even relative and absolute positioning of our bodily members. A touch sensorial map may be perceived initially as a pressure and/or a temperature distribution varying over the skin surface. In time, due to the repetitive nature of such sensory distributions the human organism is capable of discerning repeated occurrences that are similar in nature, even though they might be occurring over different regions of the skin surface, allowing for differences in these sensorial maps to be noticed. That discernment of a difference, i.e., that difference that makes a difference to someone is information (Bateson 2000). The processing of said information leads to the formulation of patterns in evaluating our environment, which make for a simplified perspective of our interactions with our environment with our bodily members.

Indeed such discernment is neither nothing more nor less than ‘spatial intelligence’ and utilizes all of our senses in developing it, and allows for continued interactions with our environment.

The subjective/objective organism

Figure 3 shows the human homoeostatic organism in interaction with its environment. The environment encompasses both the niche in which the human organism resides and other human organisms that are the unavoidable companions of our human existence. Note that the ‘Basic Unit of Analysis’ is shown to be the sole individual at the left of Figure 3 interacting in its niche and with the individual on the right. In these interactions this sole individual has as its driving motivation the satisfaction of its ‘physiological (internal and external) and social needs’. These needs may be characterized as being personal/subjective/relative (Personal-Subjective-Relative view or PSR view) and influence our view of reality such that the sole criterion that we know to avoid is any action that threatens our survival and sustenance. Since unavoidably we are surrounded by other human individuals, we need to come to terms with them. These interactions with other human organisms with a different Personal-Subjective-Relative view of reality are useful to us only if they lead to collaborative relationships. One such unavoidable collaborative relation is that between mother and child, where the collaboration leads on the one hand to the survival of the child and on the other to the survival of the species. Such collaboration requires the finding of ‘common ground’ or points of agreement, i.e., a consensual space between the Personal-Subjective-Relative views of each individual, a ‘Shared Universe’ within those two different and differing Personal-Subjective-Relative views. This consensual space brings forth an impersonal/objective/absolute perspective (Impersonal-Objective-Absolute view or

IOA view) that allows for a ‘Shared Universe’ and collaboration, and leads, from a spatial perspective, to positive interaction and union. Of course, difference of opinion and disagreement may also be discovered, leading either to indifference or disjunction between individuals with differing Personal-Subjective-Relative views or opposing Impersonal-Objective-Absolute views between groups. While the finding of a ‘Shared Universe’ might have the implication of Maturana’s[3] ‘inter-objectivity’ (2005), it is suggested to be more general as it might result from human or organismic behaviours that are outside of the realm of languaging.

Figure 3: The Personal-Subjective-Relative view and Impersonal-Objective-Absolute view of organism interactions.

In this process of recursive interactions individuals learn to reconcile their Personal-Subjective-Relative views and in so doing develop a joint consensual Impersonal-Objective-Absolute view, which may be beneficial to both. Notice that the existence of an Impersonal-Objective-Absolute view presupposes the existence of at least two Personal-Subjective-Relative views. The process of exploration, observation and discovery is a Personal-Subjective-Relative process, but the process of coming to terms so that this Personal-Subjective-Relative view is accepted by a larger community is an Impersonal-Objective-Absolute process, a socialization process. The Personal-Subjective-Relative view and the Impersonal-Objective-Absolute view coexist and develop over time. This process may also be viewed from the perspective of the scientific method and the inherency of the scientific method to lead to changing results with time due to the ever-changing nature of individual exploration, observation and discovery leading to human interactions and acceptance or rejection of said individual exploration, observation and discovery. For example, the (IOA) view that the earth is flat became overturned by the Personal-

Subjective-Relative view of Galileo, which, being initially unique, became Impersonal-Objective-Absolute as the dominant view of the world shared by all. On a more basic level Figure 4 shows an example of the concerted actions of two ants with differing Personal-Subjective-Relative views focused on their prey based on the primacy of the ‘Shared Universe’ of an Impersonal-Objective-Absolute view. This Personal-Subjective-Relative/Impersonal-Objective-Absolute perspective is believed to be generally applicable to all organisms within their own niche.

Figure 4: Illustrating the Personal-Subjective-Relative view and the Impersonal-Objective-Absolute view of ants.

The Personal-Subjective-Relative/Impersonal-Objective-Absolute view of organism interaction (described above as articulating the scientific method) may also be extended to the process of design and the procuring of a design project (such as a building) in the sense that a designer needs to ‘sell a story’ or to ‘convince’ others of the value of a proposal or idea that they then ‘buy into’. This equates to the translation of the designers Personal-Subjective-Relative view into a collective Impersonal-Objective-Absolute view. The development of a design proposal is the continual development of the Personal-Subjective-Relative/Impersonal-Objective-Absolute view of the design team and their stakeholders, the point being that the process described is social and thus expressive/applicable to understanding the process of designing a building because it is a social process effected through collaboration and the ‘buying into’ of ideas.

In summarizing, it is noted that teleonomic distributed cognition has two salient elements: a Personal-Subjective-Relative view and an Impersonal-Objective-Absolute view. The Personal-Subjective-Relative view relates to the satisfaction of

‘[…] physiological (internal and external) and social needs […]’, while the Impersonal-Objective-Absolute view relates to the requirement of the organism ‘[…] to survive and sustain itself […]’ as the organism interacts with its environment.

Configuration: A spatial problem

The spatiality of an organism is an effect of its teleonomic distributed cognition and its capacity to affect its environment. On the basis that design is a constructive activity (Glanville 2006) we propose a distributed approach to design. This and the following section serve to illustrate how we propose the preceding conceptualization may be applied. We focus on the diagrammatic-cogitating-unravelling stage of the design process – namely the point at which an architect scrutinizes and deliberates the spatial parameters of an architectural brief and determines the overall organization of the building: a point in which architectural space is tied to users, with regard to behaviour, function and context. Taking an agent-based modelling approach, we propose that the teleonomic distributed cognition of organismic engagement in the world may be cast into an artificial archetypal organism. Focusing on the sensorial capacities of organisms we seek to capitalize on the dynamic and generative processes involved to express the niche dynamics of inhabitation, the intention being to define an approach to configuring space that enables designerly thought the capacity to think about everyday life and engagement in the world in a manner that focuses on the spatiality of the organism-in-its-environment.

Architectural templates

Architects use reference models as a basis for organizing a building, drawing on conventional arrangements that describe spatial arrangement according to a particular type of building. Building typologies are standardized spatial

arrangements, pertaining to function, specifying a basic pattern or set of constraints to satisfy a particular scenario. Experience also provides templates in the form of previous buildings, ideas or projects that may be drawn on for reference. However, an architectural-template is not necessarily the plan of a previous building used as a model from which to make judgements. What may be termed a ‘spatial-template’ may be cognitive or environmental, in the sense that the environment, or specifically a given site, holds cues affecting a response or specific actions. Templates, as Ethologist Guy Theraulaz et al. claim of social insects (2003), are internal and external. Templates can occur both in the intellect of the designer (i.e. held internally, with regard to experience, education and reference models) and in the environment (the site conditions, and on an abstract level ‘spatial practice’). The template may be understood as both determined, as is the case with a reference or an internal model, or as emergent in the case of differences present in the environment. These two forms of template are typically coupled in architectural design in a process of fitting reference models to a given site. In another (more abstract) sense the environment equates to the design medium. For example, using a pen and paper lines are drawn. The next line is affected by the previous one. As a pattern forms, the reference model is adapted to suit. Basically, a blank canvas is a homogenous field. By drawing a line a difference occurs and the homogeneity is broken – in much the same way polymath George Spencer-Brown’s ‘mark of distinction’ is the elemental feature in his Laws of Form. Further lines create more difference and degrees of heterogeneity. In this sense a spatial configuration created by an architect is at a basic level akin to an organism responding to differences in its environment, in that a pattern arises out of the reading of cues: in the sense of a conversation, which occurs through the observer ‘reading’ and responding to the differences observed

(Glanville 2006). This is intertwined with reference models, experience and education, the site and the design medium. Responses are made to the interpretation of distinctions between differences. Reference models are fitted to the site through experience and education, achieved through a process of interplay defined by the design medium and the reading of differences created in the unfolding process of designing.

At the most basic level, this outlines the career of an organism, adapting to and altering its environment to sustain (and enhance) itself. Qualities of the environment are mapped and translated into actions. On the basis that all living things dwell and in so doing affect their environment in some way, designing may, in essence, be extrapolated in much the same way we perceive the teleonomic distributed cognition (and spatial intelligence) of the organism-in-its-environment, in the sense that properties of a particular scenario are mapped onto a given situation, which is then articulated in some way. Deemed to be a primitive condition created through interaction, space (or more specifically spatial configuration) emerges and fluctuates as a result of an organism's interpretation of its surroundings. This interpretation is conditional on the state of the organism and the effect of this impression on the environment: a cyclical process of feedback between internal and external factors that coalesce to effect action. This is the process of designing, a morphological process characterized by 'intentionality', whereby space is organizational, not in the sense of thought or consciousness but of orientation: what may be referred to as telos. It is a reflexive condition that is created and creative, in continual reinvention. However, whilst changeable it is habitual, in the sense that things have a tendency to act as they did on a former occasion than otherwise (Peirce 1992). It is these habitual tendencies that are cast into the artefacts and built structures that

organisms, and designers, create. This habitual tendency, however, is not fixed and is not the same as replicating arrangements taken from previous plans, which serves to maintain convention, as it relates to tendency and may thus change (or evolve) depending on the pressures exerted.

Inhabitation as a system of activities

The process of arranging room layouts is a key activity in the process of designing a building that requires skill and is intrinsically an (abstract) spatially cognitive activity. Planning is the usual way of systematically working through the arrangement of activities in a building, and for all intents and purposes is the process through which an understanding of the building programme is determined. Working out the organization of a building is one of the most important and taxing aspects of the design process concerned with the physical arrangement of objects and spaces within a room, building or site to fulfil the requirements of diverse human activities. Identified by design theorists Horst Rittel and Melvin M. Weber as wicked (1973) the success of the plan is in abstracting such problems into two dimensions, defining a plane to render them manageable, whereby the numerous intertwined components may be arranged. The problem of organizing plan layouts is combinatorially hard and has received considerable attention in the fields of architecture and engineering, particularly since the computer came to be utilized as a tool for analysis and design. In practice (whether computational or not) the process of allocating a collection of spatial components according to certain design criteria is a process of trial and error, determined by topological and geometrical relations. Architects often fall back on previous plans that provide a template enabling the architect to judge and construct a solution by interlacing the template with particular design criteria.

We view activities as ‘building blocks’, which may be combined to define a particular pattern of habitation. Such patterns distinguish typologies, whereby buildings are classified by function. Scrutinizing built structures enables us to consider ‘lived-space’ retrospectively as a system of social relations and to thereby extrapolate particular rules, or patterns, of inhabitation. Architectural theorists Bill Hillier and Julienne Hanson transported themselves within the plans of built forms to analyse their organization and illustrated how the configuration of space alters when specified from the perspective of each distinct area constituting a planned arrangement (1984). Identifying the forms of planned space to be heterogeneous they reveal buildings to be systems of activity defined by the dynamics of social and cultural goings-on. Perceived in this way ‘space’ exhibits structure and constitutes organization, becoming a sort of medium, perceived as a system of relations, articulating what Lefebvre claims of space. That ‘[s]pace is social morphology: it is to lived experience what form itself is to the living organism, and just as intimately bound up with function and structure’ (Lefebvre 1995: 94).

5.2.1. The archetypal building block

An activity in isolation is meaningless. Living things are in constant motion, and so it transfers to the things we do. We do things in relation to what we have done before and what we will do next. A pattern of habitation is a mesh of intertwined chain-like relations, determined by the activities taking place. The occurrence of an activity is functional because all activities are connected. Even though an activity may be separate from another (having no specific or physical relation to an adjoining activity) its existence may affect another. Architect William Mitchell defines ‘function’ as an action with an effect, deemed functional in relation to context (1998). The engineer, biologist-cum-philosopher and computer scientist George Kampis states that ‘the

notion of function enters into a system description when some teleology […] is supposed to work in the system' (1987: 143). An activity and its functional definition are determined by its association to corresponding activities: that an activity is defined by another activity, by which it is affected and another activity that it affects. Perceived as a chain, an activity has an input and output, thereby goal-directed in an indirect and recursive way, in the sense that something (A) affects something else (B) in a manner that supports 'B' to be or behave in the manner of 'B'. In this way an activity (or specifically function) is defined by a causal chain of connections. An activity is therefore defined functionally as a component, whose function is participation in the production (or articulation) of other activities.

The amalgamation, or association, of one activity with another depends on the constraints and criteria of the activities concerned and their relations in a particular context. It is the combination of activities performed in relation to a particular purpose, task, event or function that articulate spatial organization – in the sense that our actions fuse and define our patterns of spatiality, stipulating a particular form of habitation: what may be referred to as a 'niche'. Organized by purposeful activity, an organism's niche is a habitual condition affected at one scale by differences across boundaries and scales of composition (Hoffmeyer 1998) and at another by differences to which the organism reacts and has intention towards (Uexküll 1926; Bateson 2000). This reflexive condition is effected on the one hand by what a subject does and on the other by the effect of space on the subject. In short, activity creates space – space generates activity. On the premise that the discrete activities forming a particular pattern (or routine) of inhabitation may be extrapolated we may say, in principle, that the basic building block in shaping the built environment is 'activity'. Furthermore, that spatial configuration is driven by sensorial capacities arising from

the dynamic organizational property of habit: of doing something, that something being an action directed towards some purpose (activity) that is effected through perception and the state of the subject, conditioned by circumstance and the affect that the environment has on the individual. In short inhabitation is a combination of activities that take place in some location and have relation to other activities with which they are connected, are a part of, overlap or are adjacent to. The casting of our proclivity to inhabit is typically determined through planning, the process of which tends to focus on adjacency and connectivity on the basis of e-space. Spatial relations constitute much greater variance than the typical focus allows for.

A teleonomic distributed cognition perspective of configuration

The configuration of architectural space may be enhanced if the early (programmatic) stages of design were to be approached on the basis of organism-environment relations. Advocating an artificial life approach we propose agent-based modelling as a means of translating the potential relations intrinsic to the organism-in-its environment into spatial factors for the purpose of organizing space in a distributed process of configuration. By taking an agent-based modelling approach we seek to capitalize on the agents' discrete timing, spacing, goals, means and ends. Representing discrete activities as agents, which will self-organize according to their spatial relations, the idea is to capitalize on the dynamic and generative processes intrinsic to niche interaction to determine an arrangement pertaining to a particular 'pattern' of dwelling.

The basic purpose of a building is to shape and manage activity. Hillier proposes that the relation between space and the act of living lies in the relations between configurations of people and configurations of space. 'Encountering, congregating, avoiding, interacting, dwelling, conferring are not attributes of individuals, but

patterns, or configurations, formed by groups or collections of people' (1996: 20), which arise collectively through activity in the process of everyday life. The possible relations between individuals, and the activities they perform, equate to interactions. Visualized as a bubble form surrounding the individual in the pursuit of some task we may envisage how these interactions lead to conformations depending on whether the association between one 'activity-niche' and another is positive or negative, which may affect deformations according to the force associated. See Figure 5.

Figure 5: Niche conformation effected by organism interaction.

The patterns depicted in Figure 5 (stemming from Smith and Varzi) are social, relating to various cases of two-tenant/two-niche interaction. These may be extrapolated to define a series of relation potentials (depicted in Figure 6) to illustrate possible forms of interaction that give rise to the sorts of association that one agent may have with another. The forms of association, being social, equate to degrees of consolidation. We might, in the first instance, imagine a friendly encounter, whereby the individuals are allied or congenial: a sociable condition in which the niches combine or fuse, articulated by 'a' and 'b'. Of course 'a' may also be viewed negatively, as dominance. A positive encounter may transpire, whereby the two join but remain separate, as in'd', which may alternatively be a case of hostility. In the case of 'c' the two may be disassociated while having a neutral disposition to one another, in which case the two niches remain separate but may overlap. Else there may be hostility, or one may be contrary to the other, causing deformation (in the case of 'd') or repulsion (in the case of 'e'). We thus see (from left to right) instances of coupling, nonchalance, encounter (which may be a collision or impingement) and contrast (which may be conflict or incompatibility). Withstanding 'c' and 'e' the exchanges lead to deformation. These forms of interaction are applied as possible

forms of association between agents, depicting discrete activities, to serve as the basis for their agency. These associations thus define the manner in which the agents may interact and how their association may be projected spatially. Figure 6 illustrates how these interactions may be projected spatially to define a series of relation-potentials that are subsumptive. The relation-potentials distinguish the spatial-property of a relation as a scale, not of dimension but as a gradient, or degree of consolidation.

Figure 6: Potential relations occurring between one activity-niche (agent) and another.

Applying these potential relations to the forms of association between one activity and another we transfer the form of conformation between one activity-niche and another into behaviours. We thus propose modelling a collection of discrete activities (as agents) pertaining to a particular spatial scenario (or more specifically a building programme) such that the concluding pattern is something that emerges through the interrelations between agents representing various discrete activities: on the premise that ‘buildings transmit information through their interior structures, defining particular patterns, or formations, of space’ (Hillier and Hanson 1984). The notion is that the proposed method of configuration might unveil the intrinsic pattern underlying a particular programme of habitation, generating a pattern of space – or spatial morphology – in relation to configurations generated through associational networks of an array of activities pertinent to a given programme.

The agents represent a region of space specific to a discrete activity constituting an archetypal organism, which has the capacity to distinguish self from non-self, and thus affect and be affected by its environment. A difference detected may affect an

agent by constituting a force, affecting it in a centrifugal (attract) or a centripetal (repel) manner, thereby influencing its conformation (as in Figure 6), state or position. Differences are therefore ‘observed’ by an agent as a result of their meaning. Such a model would enable a process whereby configuration is the result of the multiplicity of interactions between agents with their own timing, spacing, goals, means and ends. At its most basic level the attract-repel mechanism in the model relates to social relations that contrast, defining conditions analogous to situations between activities that have conflicting social properties, such as one being public and the other private or environmental properties where the effect of one is noise whilst the requirement of another is quiet. In such cases one agent will seek to evade the other. However, the properties of activity are not so straightforward as our activities take on different characters in relation to context and the disposition of the ‘actor’. For example, the activity of writing this article fluctuates from sitting in silence to ‘requiring’ noise (music), from sitting to standing and, at times, pacing, and at other times turns to the distinct activity of making tea. Therefore the associations between the activity of ‘working’ (i.e. writing this article) and other activities alter. The associations are not fixed. An activity has tendencies, and these fluctuate depending on physiological and social needs.

The idea is that the agents conformation (or specifically that of the activity-niche) and thus the concluding configuration are determined by the behaviour of the agent population, whereby the agents adapt to their environment according to the differences that they ‘perceive’. Relating this to how people respond to their changing environment and how our activities change or the way we alter our surroundings to reflect (for example) a changing climate we can see how the activity-niches transformation may reflect this: changing from one stable state to another.

Before detecting a difference an agent is in one state, but detecting ‘a difference’ it will respond to that difference and settle into another state once that difference has been ‘accommodated’: i.e. it reconfigures its boundary conformation to changing conditions. The proposed model outline thus reflects how an organism moves from a stable spatial domain, representing a given understanding of said spatial domain at a specific time, to another stable but different spatial domain due to the organism sensing changes in its environment and adapting to such changes. For example, in much the same way that the internal state of an organism may change according to external perturbations, an inhabitant sensing a changing climate may alter the configuration of his or her living quarters to accommodate or embrace changing external conditions, thereby satisfying physiological needs. The proposition is an analogue of a bottom-up approach to architectural design that takes into account that we as organisms interact with our ever-present changing environment and redefine our spatial domain depending on our sensory interaction with the said environment. The changes affecting our sensory interaction are not only physiological, but are social too. For example, whilst we might engage in seasonal changes of our living quarters due to perceiving changes in our spatial domain consequent to external conditions, changes may also occur as a result of social or life events.

This is not the modelling of people’s movement or goings-on but a conceptual representation of behaviour. In an abstract sense human beings are perceived as agents running within a maze of interrelated, integrated, entwined activity patterns. It is the performance of activity, influenced by context, which generates space, and defines spatial configuration in the context of designing conditions of spatial patterning, the point being to determine an approach to spatial configuration that is implicitly representative of the organism-in-its-environment: i.e. its action and being.

Conclusion

This article explores the newly defined concept of teleonomic distributed cognition in a spatial and temporal domain and proposes how this conceptualization may be applied to how architectural space is organized. The modelling methodology outlined explores a biological definition of space and organization. The proposition is based on the distinction of a difference, and as such, the capacity of an organism to sense and its coupling to its environment, that this is spatial, and thus expressive of spatial intelligence, presenting a platform from which the authors aim to develop an approach to generating (architectural) spatial formations that articulate the ‘nature’ of inhabitation. The approach outlined in section 6 describes how the conceptual position presented (in Sections 2–5) may be actualized. Just as ‘the proof of the pudding is in the eating’ the next step in this project is to develop the agent-based model outlined in Section 6 to apply the theoretical perspective and to test any results from the implementation.

Space as lived must be tallied with the traditional conceptualization of mathematized space because whilst space has geometrical and topological characteristics it is actualized through behaviour. There is a binding connection and reciprocal influence between the environment of an organism and its behaviour that affects the organism´s being and the activities that it performs. As such there is a structural coupling between intention and the environment, in much the same way that space as lived and mathematized space are two sides of the same coin. Architectural space may thus be derived from the properties of unity between an organism and its environment or another organism that may be construed as part of that environment. The premise is therefore that some characteristics of space comply with those of a complex adaptive system that produces its own organization in response to

differences in its environment. Our proposal is an attempt to translate these differences (information) into ‘object’ to articulate spatial intelligence, casting the teleonomic distributed cognition of an organism into a method of generating architectural spatial formations.

A critique of the approach argued for may be that buildings generally allow for the fluctuating and changing demands of inhabitants. Buildings may be adapted and altered, and rooms often allow for changes in the inhabitants idiosyncrasies. This is true of many buildings. Looking at residential buildings, for example, Victorian and Georgian town houses (in the United Kingdom) are commonly occupied in ways that vary widely today from the style of living that they were originally intended for. This is the merit of such house forms. But space standards are squeezed in today’s economic climate and few people live in a house design specifically for them. The Royal Institute of British Architects recent campaign (Homewise: Without Space + Light) highlights the impact of space on the way we live our lives. The approach argued for ways to address the imbalance that Lawson (2001) and van Schaik (2008) highlight by focusing on our coupling to our environment and how this is effected through teleonomic distributed cognition.

In closely examining the process of architectural practice we find that it corresponds to a process of teleonomic distributed cognition where spatial intelligence is not only a requirement but also a consequence for its practice. Recognizing it as such lends clarity to the design process. Identifying the Personal-Subjective-Relative and Impersonal-Objective-Absolute aspects emphasizes the sociality of design as a process in which stakeholders need to recognize the value of their unique Personal-Subjective-Relative views as intrinsic and fundamental to achieving the Impersonal-Objective-Absolute view that projects require to make them effective.

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IMAGES

Figure 1. Lived-space is a mediation of the mental and physical dimensions of space.

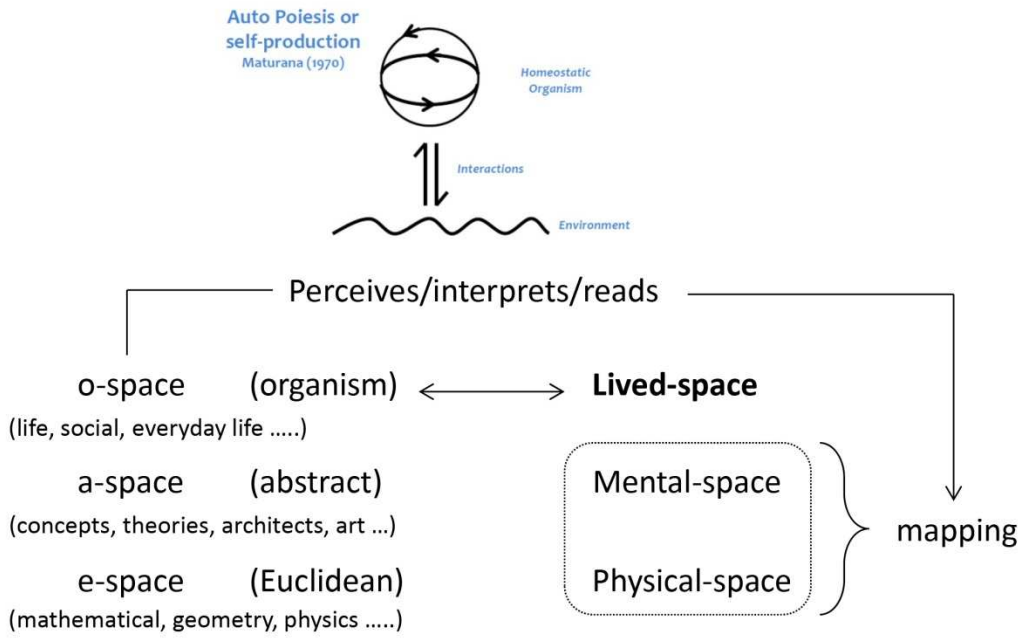


Figure 2: System-environment coupling (redrawn from Maturana and Varela 1987).

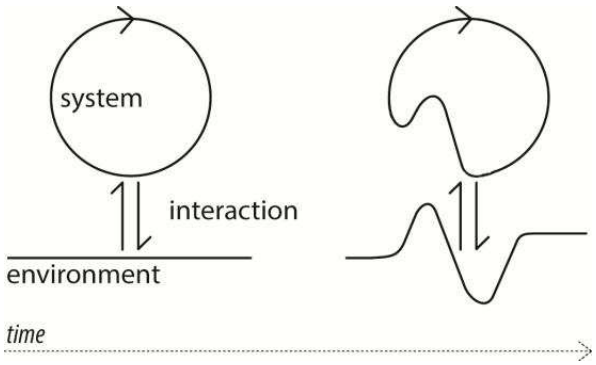


Figure 3. The Personal-Subjective-Relative view and Impersonal-Objective-Absolute view of organism interactions.

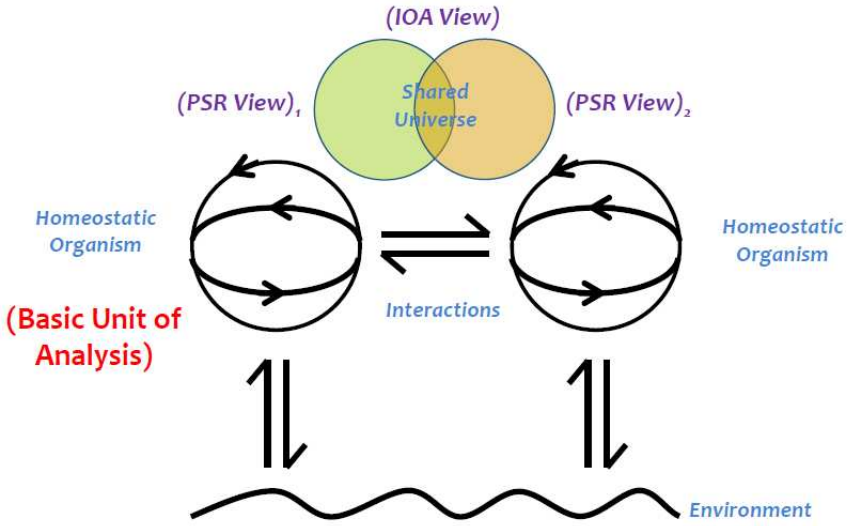


Figure 4: Illustrating the Personal-Subjective-Relative view and Impersonal-Objective-Absolute view of ants.

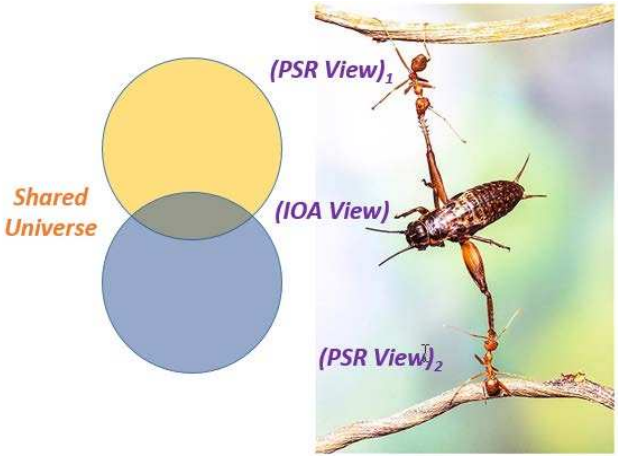


Figure 5: Niche conformation effected by organism interaction.

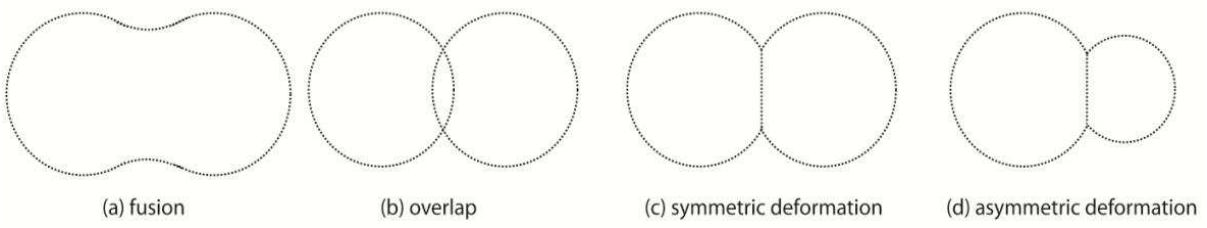
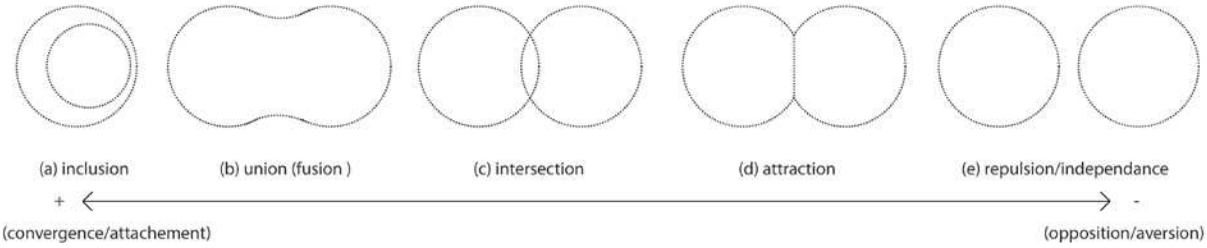


Figure 6: Potential relations occurring between one activity-niche (agent) and another.



Notes

[1] We argue that spatial awareness is intrinsic to all living things because living things are coupled to their environment and interact with their environment through their capacity to sense (i.e. that they can detect differences in) and affect their environment. This view is elucidated by the theoretical biologist Jacob von Uexküll, who explicates a bio-cybernetic and semiotic explanation of the organism-in-its-environment and establishes a biological conception of space (1926). Our argument is theoretical and confined to the sensorial capacities and general condition of a token organism-in-its-environment: the living cell being the fundamental form. We do not refer to types, or individuals, for which studies show that people's spatial cognitive abilities differ (Hegarty et al. 2006; Marchette et al. 2011; Weisberg et al. 2014). Such studies scrutinize people's ability to navigate, to establish their spatial cognitive abilities. These scientific studies are concerned with the capacity of individuals to navigate, distinguish and articulate features in the environment to understand (spatial) cognition and establish their ability to cognize spatial scenarios. We account for the organism-in-its-environment as both a subjective and an objective being (that it has a PSR and an IOA view: see Section 4), whereas the said studies tend to focus on the validity of subjective spatial awareness and the objective capacities of individuals.

[2] This definition is distinct from that of Hutchins (2006), who defines distributed cognition as 'an approach to the study of all cognition' where 'cognition is distributed across brains, bodies, and a culturally constituted world'. Thus Hutchins' 'distributed cognition is not a kind of cognition at all, it is a perspective on cognition'. Further, it has no connection to the biological origins of a human organism and that is the principal distinction that is being made here.

[3] Humberto Maturana is a Chilean biologist and philosopher. He is best known for the concept of ‘autopoiesis’, which he developed with Francisco Varela, to explain how an organism can self-organize and self-maintain through structural determinism and coupling with its environment.