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Manifold Spaces and Patterned Potentialities

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Abstract

The research aims at providing a new perspective and methodology to dynamic space setting as a mode articulation for intensity, transformation, and change pointing to more versatile, resilient, and ecological urban assemblages. The anticipation apparatus proposed for architecture and the city is a landscape of Alexandrian Design Patterns and intensive variables that simulates spatial contingencies and connects them with actual bodies as an extended mode of prediction and design. The city is represented as an N-dimensional manifold, a plane of variable dimensionality where its dimensions are used to represent its sociospatial becomings. At the same time, the manifold itself becomes the space of possible states that city can have, an apparatus that structures the city's sociospatial potentialities and dynamically patterns its material reality.

Keywords

Manifold; Design Patterns; City; Intensive variables; Dimensions; Apparatus.

Introduction

This article attempts to better understand spatial materiality exploring and advocating for the agency of technical objects, their meanings and desires being represented and activated. Close to the new materialist informatics' agenda, the affective capacity of space enacted is mobilising materiality's relational, contingent, and emergent nature to provide a new perspective of how the built environment is being produced, constantly made and un-made (Coole and Frost, 2010, p.29). Thus, allowing for space to be understood, visualized, and potentially designed in an open, integrated, and reversible format. The research provides a new perspective and methodology to dynamic space setting as a mode of feeling and information-sensing for architecture and the city. The *anticipation apparatus* proposed simulates spatial contingencies and connects them with actual bodies as an extended mode of prediction and design. Recognizing the materiality of form and the forming of matter, design is in this respect operational, prioritising production processes to end results (Sauvagnargues, 2015, p.74). Using information as a form of matter, the apparatus systematizes possibilities of appearance and capacities for spatial transformation (Passia and Roupas, 2018, 2021).

To think in terms of not *what space is* but *what it can be*, the research is drawing from the Deleuzoguattarian concept of *the virtual*, "a mode of reality implicated in the emergence of new potentials" (Massumi, 1998, p.16). This mode is *the reality of change and continuous transformation*, entailing a shift in the very object of the architectural design process. While traditionally invested in form as a beginning and end result, architecture within the topological turn is about thinking in terms of possibilities for change, monitoring how form may evolve and adapt (Massumi, 1998, p.18). In this paradigm, according to Massumi, form is not conceived but is coaxed out from its virtuality, at the same time sweeping the architect away from its creative primacy to assume a new role as a catalyst or mediator in this process(es) of becoming. An important shift from *what the form is* to *how it can be deformed* takes place, where "form emerges from virtualities being ceaselessly actualised" (Marenko, 2015). To grasp what constant change means for the architecture discourse, the research taps into topology as a pool for working concepts and a conceptual

vocabulary. Space then becomes a topological engine of potentialities, recursively calculating differentials and uncertainties, an *anticipation apparatus* (Parisi, 2012, p.168; Massumi, 2007).

Using topological media for the study of spatial dynamics provides tools, models, and concepts for understanding and designing of space that are neither typological nor morphological. Reconceptualizing the built environment in these terms allows to explain how and why space changes at different levels and in different ways; how space is fully intensive rather than extensive, that is, spaces being evaluated in terms of their production processes and possibilities for change; how space is constituted in relations rather as having some essential properties, values and norms; and finally, to accept spatial change as affirmative and immanent rather than negative and externally defined. The anticipation apparatus is a mode of articulation for *intensity, transformation, and change* as other modalities of spatial relations and dynamics of structure (Lury et al., 2012, p.4). It provides to architecture a set of working concepts for thinking and conceptually experiencing the recursive process of the actualisation of space; a movement through registers: *from the virtual to the actual via the intensive*.

To elaborate on the intensive reality of space while at the same time remaining connected to the actual register, we turn to *patterns*. As patterns are tied into the morphogenetic processes that shape them (Closkey and Vandersys, 2017, p. viii), they render visible the intensive nature of these processes that in turn give rise to actual substances (Bonta and Protevi, 2014, p.16). To that end, the research points to architect and design theorist, Christopher Alexander and his 65 Design Patterns[1], as presented in his book, *A Pattern Language: Towns, Buildings, Construction* (Alexander et al.,1977). *Design Patterns* are used to differentially define space as variable and intensive media advocating for an important ontological shift *from objects to processes and material fields* (Sha, 2013, p.90). At the same time, space on these fields can be perceived as relational, intensive, variable, and continuous.

[1]The total number of invariant Patterns in Alexander's archive are 83. For the purpose of this experiment, Patterns referring to construction – ranging from 205 to 253 – have been left out. The sample selected contains the following 65 Patterns:1,3,8,9,11,14,21,22,30,31,36,37,40,41,46,48,49,51,52,53,60,61,67,69,79,80,87,88,95,98,10,104,105,106,107,110,112,115,117,119,124,127,129,130,139,140,141,148,155,159,160,161,163,167,168,171,172,174,179,180,183,188,190,191,197.

To investigate the virtuality of space, the concept of a Deleuzian *multiplicity* is introduced, a philosophical concept equivalent or close to a mathematical *manifold* (DeLanda, 2005, p.10), now pointing to architecture and the city. As the manifold's architecture gets progressively defined, Alexander's Design Patterns organize a relational field of emergence where space is perceived as *assemblages of variables* and specific Design Patterns explain its possible mutations. The manifold is used to change the understanding of existing design problems and also address their changing conditions without the need to refer to subsisting dimensions. Constructing new cartographies of diagrammatic connections of both existing and possible objects, the manifold is actively marking continuities, similarities and connectivities.

The basic plan of this essay is as follows. The first section introduces Alexander's Design Patterns as relational frameworks that explain and shape recurring processes, relationships, and structures regarding space. It points to their relevance to articulate both the city's production processes and its possibilities for change. The second section deals with the theoretical framework needed to think about moving through the different ontological registers, focusing on maps and manifolds. It explores the different spatial regimes, the beings that inhabit them and their implications in the actualisation of space. The following section elaborates on processes of making manifolds drawing from manifolds' relations to science and philosophy. It provides a set of working concepts and a conceptual language to explore manifolds and the production of the multiple. The two subsequent sections follow through the production of the anticipation apparatus directly drawing from Daniel Smith's deconstruction of the Deleuzian concept of Life as a non-organic and impersonal power (Smith, 2012, p.189-221). For the first part, "the power of abstraction" is elaborated on outlining an extraction process on Alexander's archive of Design Patterns. At the end of this part, intensive variables sampled from the Design Patterns become the apparatus' elements. In the second part, "the power of creation" and designs the apparatus' architecture organizing its elements into a vectorial field of connectedness composed of Alexandrian Patterns and intensive variables are explored.

Design Patterns

Christopher Alexander attempted to establish a design methodology aiming at a generative production system for architecture. His work has defined the development of architectures of information (1960-1985) by applying informational processes and technologies in architecture (Steenson, 2014, p. 3). By documenting the design problem as an informational problem, he visualised the informational example in architecture and constructed a generative system for architecture, as described in his book *A Pattern Language: Towns, Buildings, Construction*. His most important contribution lies in describing architectural form through visual information structures – the *Design Patterns* – in documenting them as solutions to recurring problems of the built environment and placing architectural form under the heuristic understanding of architecture as a problem to be solved. He also proposed shaping architecture into networks and languages of Design Patterns under a generative logic, his Pattern Language.

Patterns are relational frameworks that both explain and shape recurring processes and relationships while giving rise to actual material structures (Closkey and Vandersys, 2017, p.7i). They have associative properties in that they are made of multiple entities, able to be further analysed into their constituent parts. Patterns shift the focus away from entities towards their relationally and connectivity. Each Design Pattern, according to Alexander, is a generative system: a kit of parts with rules about the way these parts may be combined (Alexander, 1968, p.605). As Bateson explains,

> We have been trained to think of patterns as fixed affairs. In truth, the right way to begin to think about the pattern which connects is to think of it as primarily a dance of interacting parts and secondarily pegged down by various sorts of physical limits. (Closkey and Vandersys, 2017, p.46)

By shifting his interest from the form's elements and focusing on the relationships between those elements, what Alexander proposed is a significant upgrade regarding the flexibility of form and its ability to exist as a product of differentiation, to change and create iterations of oneself.

At the same time patterns are tied into the production processes that shape them. They are the "surface" expression of underlying interactions and movements forming

the physical conduits, pathways, and networks for energy, materials, and forces to actually flow and interact" (Closkey and Vandersys, 2017). Usually, as Bonta and Protevi point out, "the extensive properties of actual substances cannot be used to predict the virtual structures of intensive processes, because the extensive properties *hide* the intensive nature of the morphogenetic processes" (Bonta and Protevi 2004, p.16). To that end, Design Patterns allow for an important shift: they render visible the intensive processes that produced them while at the same time actively connecting them to the extensive properties of actual substances. In Alexander's archive, each Pattern is described in the form of a three-part rule, expressing a relation between a certain context, a problem, and a solution (Fig.01). Each Pattern's internal structure lies in its solution where communications between its component parts and rules take place, resulting in the Pattern's actualization (Deleuze, 1993, p. 100). The solution "describes the field of spatial and social relationships which are required to solve the stated problem, in the stated context" (Alexander, 1977, p.xi). It consists of an instruction along with a diagram that visualises the solution, with labels to indicate its main components. Each component is a process rather than an end product, occurring gradually, at different speeds and rhythms.

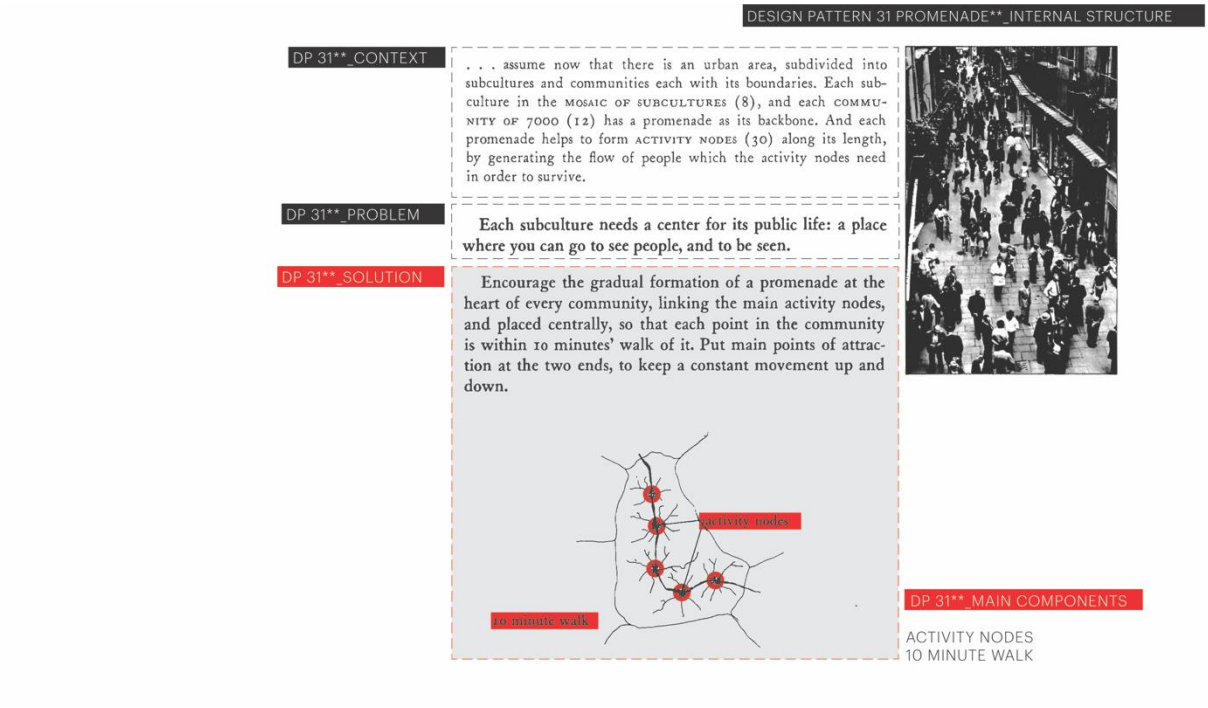

Figure 01. Design Pattern 31 Promenade**_Internal structure (Passia Y. and Roupas P., 2021)

Design Patterns present a valuable reservoir to articulate space in a perpetual state of becoming so as to enable deformation and change . They are immanent in the physical world, that is, they are internal and normal. They are constituted in relations rather than being categorial and at the same time they allow us to tap into the intensive dimension of space while remaining closely affiliated to the extensive world. Being formal, material, or temporal recurrences, Design Patterns are given the modal status of the possible while their sum points to all[2] *the possibilities of space,* all the possible states space can have.

As the research aims at continuity and deformation to allow for spatial change and reversibility, it focuses on how Design Patterns can become fully intensive, variable, and associable media and on how to topologically interconnect them in a continuous format (more on this in the last two sections of the paper). Pointing to the Patterns' components rather than to Patterns themselves, assemblage dynamics radically enhance their variability, creating ever-new connections and interactions among them. While in Alexander's Pattern Language active links are created only among Design Patterns, now the focus is placed on their component parts. This way, one can now directly tap into the dynamics of particular processes that shape and "unshape" any Design Pattern. At the same time, components are now free to topologically interconnect without referring to their respective Patterns. For example, an important component of Pattern "31.Promenade" is *public density*, also used by "Patterns 3.City country fingers," "21.Four-story limit," "30.Activity nodes," "61.Small public squares," "139.Farm-house kitchen", and "179.Alcoves." These Patterns now form a cluster of design solutions that focus on the process of *public density*, at different scales and levels of detail. Their multiple topological interconnections become a means to introduce new continuities into the discontinuous world, exploring how space can be made and unmade, the concepts, paths, and drives that guide its various actualisations (Lury, Parisi, Terranova, 2012, p.4).

At the same time, Design Patterns are here theorized as spatial assemblages composed of heterogeneous elements – themselves being parts of larger assemblages – that enter into relations with one another while their components'

[2] Design Patterns' archive is itself in a process of becoming as new Patterns are being continuously documented. In that sense, both their "sum" and "all" are used in a non-reductive way.

ability to engage is contingent. Moving away from conceptualizing systems as seamless wholes, assemblages provide "the possibility of analyzing both the contingent interactions between parts as well as the emergent properties of the complex whole" (DeLanda, 2006, p.10). In this context, any Design Pattern's component may be detached from its assemblage and plugged into another where it forms different interactions. Such an approach further emphasizes fluidity, mutability, and interchangeability of spatial components, producing evolving systems that interact with each other.

Allowing for components to attach themselves to existing patterns or detach from their assemblage states is formative for the apparatus' plasticity and capacity to produce ever-new Design Patterns for sensing and calculating spatial data. Let's postulate the component of public density detaching itself from Pattern 31, an action that would significantly alter the design solution towards a promenade that is less public and more private. This could result in a variation of Pattern 31 or — as more components are being detached or attached — a totally new Pattern potentially able to address novel or emergent design problems rather than pre-set ones. This becoming-nomadic of Patterns marks the process of their transformation "into the active production of multiple forms of belonging and complex allegiances" (Braidotti, 2017, p.301). Systematising space and the built environment in terms of variable components and intensive processes while at the same time capitalising upon them as mechanisms for spatial continuity, advocates for design that is open to alternatives, revisions, and contingencies.

From Virtual to Actual via the Intensive: Maps, Multiplicities, Manifolds

As we are invested in exploring the material becomings of space, its spatial and social tendencies and capacities not yet actualised but fully real, this part will focus on better understanding the actual, the virtual and the intensive, in terms of their modal status, their interconnections and respective representations. According to writer, artist, and philosopher Manuel DeLanda, the three ontological aspects that constitute the Deleuzian world are *the virtual, the intensive and the actual* (Fig.02). They should not

be thought of as levels but as moments in a process of unfolding[3] (Bonta and Protevi 2004, p.16). At the same time, they present three different assemblage states: moving from the virtual to the intensive and to the actual, there occurs a gradual phase transition in which *quality changes into quantity*. We can imagine the virtual as a continuous space with no differentiation that progressively becomes discontinuous into intensive and gradient regimes (DeLanda, 2010, p.133) to give place to the intensive. In turn, the intensive further differentiates into actual spaces and substances. According to Delanda, the three domains foster significantly different beings. While the actual is the site of *final products* with their extensive and qualitative properties, the intensive is the site of *production processes* with their intensive differences and critical points of change. The site of the virtual is the scaffolding of these production processes, a structure that explains *regularities in both the processes and the products* (DeLanda, 2010, p.128).

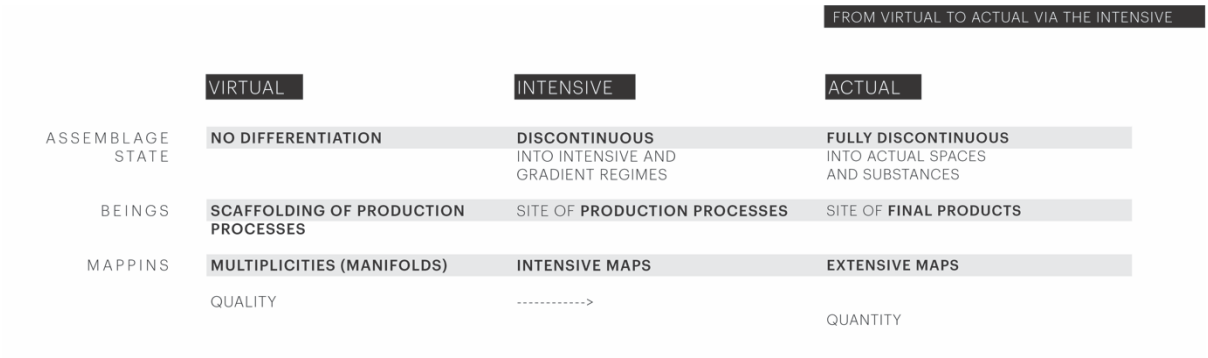

Figure 02. From Virtual to Actual via the Intensive (Passia Y. and Roupas P., 2021)

When pointing to architecture and the city, what do final products, processes or their intricate scaffolding mean and how do they look? To further explore these three domains we turn to their respective mappings that are significantly different. *Extensive maps* capture spaces that are bounded by natural and artificial extensive boundaries that extend in space up to a limit marked by a frontier. These spaces have extensive or metric features, defined both by their extensive and qualitative properties. They are the final products e.g., the city's actual spaces such as the promenade depicted in the

[3] Bonta and Protevi (2004, p.16) further explain the thee registers "as moments in a process of unfolding marked by symmetry-breaking cascades".

indicative picture of Pattern 31 (Fig.01). Intensive maps**,** on the other hand, capture differences in the intensity of a particular property as well as the dynamic phenomena that are driven by such intensive differences. (DeLanda, 2010, p.115). The spaces captured on these maps are non-metric or topological, intensity zones "bounded by critical points of change, whether in temperature, pressure, gravity, density, tension, connectivity and more, and define abrupt transitions for the state of natural and artificial objects that inhabit them" (Buchanan, 2005, p.80). Intensive maps capture spatial gradients **—** their intensity zones and critical points of change — and explain how space is produced. While all Design Patterns are processes and hence intensive in that respect, only six Patterns within Alexander's initial archive capture spatial gradients and intensity zones. Their structure is gradient-like and their diagram maps a spatial relationship organised into intensity zones. Such an example is Pattern "36.Degrees of publicness" (Fig.03), which maps intensive relations of *decentralisation* and *concentration.* Its component parts are significantly different. Spaces on intensive maps are morphogenetic processes e.g., social, material, spatial, political etc. In these terms, *intensive and extensive spaces are genetically connected*: the former are the site of processes that produce the latter. Thus actual space as we experience it is there as a result of its many gradients.

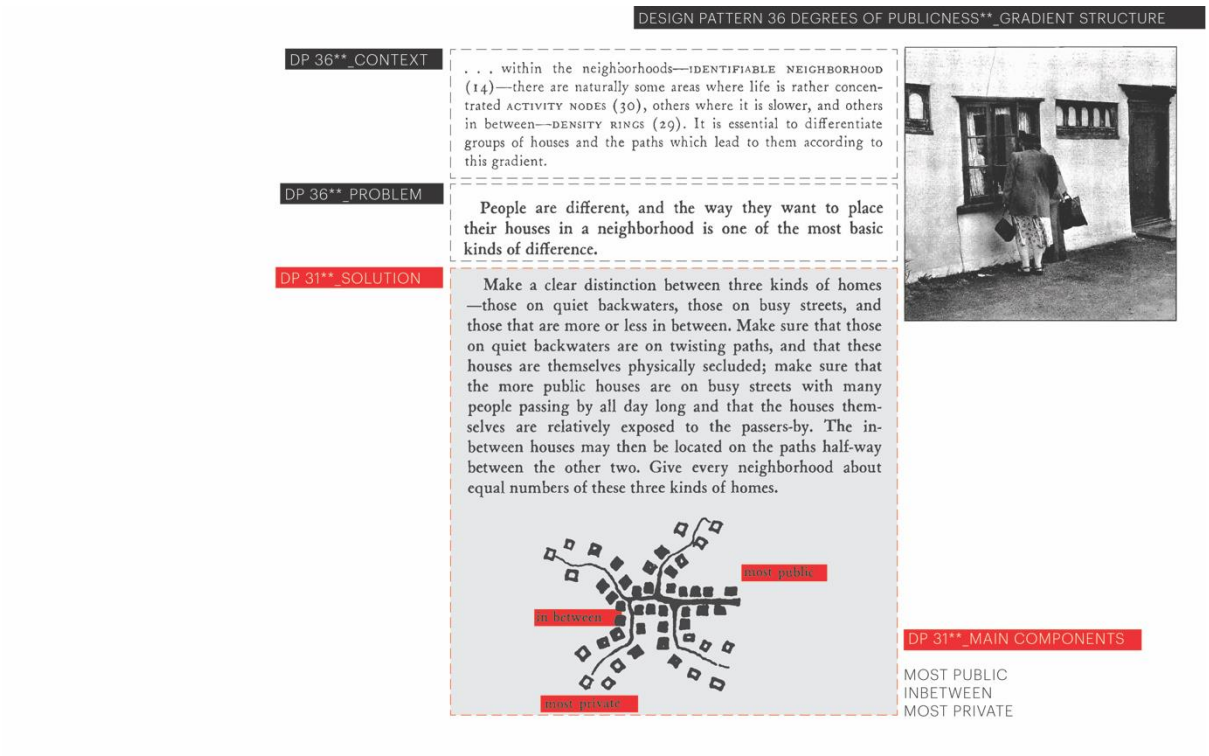

Figure 03. Design Pattern 36 Degrees of Publicness**_Gradient structure (Passia Y. and Roupas P., 2021)

Virtual maps we postulate to be quite different, ideally continuous and fully qualitative assemblages. Virtual maps capture the structure of possibility spaces, the dynamical landscape of the city's complex system, including its patterns of behaviour and the thresholds where it changes patterns (Bonta and Protevi, 2004, p.19). Virtual maps are genetically connected to intensive maps too since they produce them as they unfold. The virtual domain is the site of potential transformations that structure the city's intensive production (or morphogenetic) processes. *Thus actual space as we experience it is there as a result of its many gradients, and its many gradients is the result of their virtual structure.* Deleuze conceives of such virtual structures as *multiplicities*. According to DeLanda, "multiplicities specify *the structure of spaces of possibilities*, spaces which, in turn, explain the regularities exhibited by morphogenetic processes" (DeLanda, 2005, p.10). Drawing maps of those structures would get us thus closer to our apparatus, reconceptualizing space and the built environment as a dynamical landscape of potentialities.

To that end, the concept of *the manifold* is introduced, a philosophical concept equivalent or close to a *mathematical* manifold (DeLanda, 2013, p.10). Dynamical

systems use manifolds as their models to provide a scaffold for their intensive processes. Manifolds are closely related to the concepts of “state space” or “phase space” and to the concept of the virtual as the modal status of the set of possible states of the system along with the probabilities of attaining a particular subset of those states. A manifold is an abstraction of Euclidean space, an N-dimensional topological surface composed of local subspaces without the need for a global embedding system. On manifolds, one can specify neighborhoods and articulate their proximity — categorial, spatial, temporal — without having to use rigid lengths or metric quantities (Sha, 2013, p.100). In that sense, manifolds are topological structures that represent continuous and continuously varying fields as an approach to articulate objects as they shape and dissolve in those fields (Sha, 2013, p.90). Relations of continuity and connectedness in those fields are established in terms of vectors and vectorial gradients (Lury, Parisi, Terranova, 2012, p.23). The manifold can be then used to articulate how space is produced as well as capture the different possible states in which it can exist. Instead of thinking of space through points and their connections, the manifold’s points might be entities, events, or spaces, further exploring the flexibility of space. Through the manifold, it becomes possible to measure the entities’ proximity by establishing connectivity protocols and measuring their communication patterns. Transformations of both the entities on the manifold *and* their relations are open and immanent instead of causal and linear, radically maximising the variable character of space (Lury, Parisi, Terranova, 2012, p.8).

Making Manifolds: Terms, Concepts, Techniques, and Methods

To make a manifold for space and the city, we will explore two distinct discourse areas that delve into *the production of the multiple* (Fig.04). Each shall provide a very elaborate framework but also working concepts and the vocabulary able to enrich our world-view of manifolds and their production processes. The first, more scientific discourse draws primarily from manifolds’ connection to “state space”, a concept developed by mathematician Henri Poincare towards the end of the 19th century, to provide a visual representation of the behaviour of dynamical systems (Bonta and Protevi, 2004, p.17). From that theoretical ensemble we will mainly focus on *a step-by-*

step method on how to construct such a "state space" (Bonta and Protevi, 2004, p.14-20; DeLanda, 2005, p.85). The second and more philosophical discourse, though not entirely disconnected or separate from the first one, draws on Deleuze and Guattari's terms, concepts and methods as *processes of making a manifold*. These include but are not limited to, their Cartography method (Bonta and Protevi, 2004, p.22), Life as a non-organic and impersonal power (Smith, 2012, p.189-221), and the term "Concept" as a multiplicity (Deleuze and Guattari, 1994). Often, terms of the first discourse may be referenced in the second but not in the same way as in science. The philosophical discourse's main contribution lies in its persistence on providing *an ontology of variable entities* — be they bodies or concepts, organic or non-organic — as purely intensive or schizoid bodily assemblages (Smith, 2012, p.209).

Figure 04. The production of the multiple: terms, concepts, techniques, methods (Passia Y. and Roupas P., 2021)

Postulating on manifolds as "state spaces"[4], geophilosopher Mark Bonta and philosopher John Protevi (Bonta and Protevi, 2004, p.17) provide us with a step-by-step method of constructing such a "state space". We attach it along with some notes

[4] According to Manuel DeLanda, the process of making a manifold consists of two parts. First, "each of the manifold's dimensions is assigned values from one of the degrees of freedom of the system itself "(DeLanda, 2005, p.85). Then the manifold becomes its "state space or phase space" (DeLanda, 2005, p.14).

on our end for each step, drawing primarily from the second and more philosophical discourse, as a basis for the city's manifold-like apparatus.

1. Identify important aspects of a system's behaviour, which are called its "degrees of freedom".

a. The dynamical system at stake here is space and the city while its important ways of changing are the components of the assemblage, the elements of the multiplicity (Bonta and Protevi, 2004, p.22). To establish the city's ways of changing, the Deleuze and Guattari's Cartography method advises that we *use measurements of both its extensive and intensive properties of the system*, that is, properties of both actual city spaces and of their production processes (Bonta and Protevi, 2004, p.16).

b. Exploring the virtual scaffolding of intensive processes that give rise to the actual city along with its possible divergent actualisations, points to "placing the variables themselves in a state of continuous variation" (Deleuze, Guattari and Massumi, 2005, p.369). Then, the city's spatial intensive variables — connecting both to its extensive and intensive properties — are to be placed in variation.

c. The system's components are themselves assemblages at different levels or moments of unfolding which in turn means that each component is expected to have its own "degrees of freedom". Or as DeLanda notes,

> "the building blocks used as components of an assemblage are themselves assemblages operating at a smaller scale, and we should be able to give causal mechanisms defining the processes that actualized them, as well as the mechanism – independent structure of their own possibility spaces." (2010, p.102)

A multiplicity's components, spaces or regions of intensity are gradients which means that they are themselves state or phase spaces defined by their respective dimensions or "intensive ordinates" (Deleuze and Guattari, 1994). Both the system and each component claim for their own variable

dimensionality thus defining the system's patterns of behaviour at different levels.

2. Construct a space with as many dimensions as the degrees of freedom of the system under consideration.

a. By dimensions, we mean the variables or coordinates upon which a phenomenon depends (Deleuze, 2004, p.182). Then, the dimensions are zones of intensity used to represent properties of a particular physical process or system (DeLanda, 2005, p.13). The apparatus will be a model of the spatial and social processes that produce the city, its dimensions directly connecting to these morphogenetic processes. The term "model" is here used in the context of a becoming or a process, in constant variation.

b. Dimensions, as well as degrees of freedom in this context, appear to be discrete or constant. A Deleuzian multiplicity however, has a variable number of dimensions (DeLanda, 2005, p.12) to accommodate for both the complexity of the system under observation and its emergent properties. In the next section, we will use Design Patterns and an extraction process to set dimensional surfaces or better yet, explore the principles of their dynamic genesis.

c. We have established that both components and dimensions should be placed in a state of continuous variation. The city, like a schizoid body, knows no constant organs or dimensions, either in function or position. And most importantly, organs or dimensions can be experienced as pure intensities capable of being linked together in an infinite number of ways (Smith, 2012, p.208). The same holds for the variable components of each dimensional surface. To that end, Design Patterns will be transformed into intensities capable of producing a vast array of sociospatial processes regarding the city, thus giving rise to highly dissimilar final products and actual spaces.

3. Represent each state of the system by a single point with as many coordinates as there are dimensions.

a. Coordinates or values, as well as dimensions in this context, appear to be discrete or constant. However, they are potentially always changing in number and/or composition as the system evolves.

b. The term “coordinates” relates to both values and variables upon which a phenomenon depends.

c. The idea of the single point relates to the manifold being a “continuous, defined multiplicity” (Deleuze, 2004, p.182). By continuous, the manifold refers to the differential calculus which means that changes in a variable relate to changes in all other variables at the same time since variables are topologically bonded. The “defined” part refers to the elements being defined by these relations of reciprocal determination. As entities on the manifold — on all scales — are reciprocally determined, a change in them means a change in the multiplicity “in its order and its metric" (Deleuze, 2004, p.182).

4. Follow the movement of the point, which represents the changing states of the system as it produces a trajectory through state space, with time as a running parameter.

a. Once the apparatus is an N-dimensional, continuous, defined multiplicity, its network topology will allow us to explore how its form directly connects to its function. Patterns of connection between its variable elements will be able to advocate for their communication possibilities. Moving on the manifold’s paths and gradient neighbourhoods will further conceptualise space towards its possibilities for change.

5. Attempt to solve the equations governing the trajectory and thereby predict the system's behaviour.

a. The apparatus in the form of a manifold postulates on the city’s possible spatial and social becomings acting as the city’s virtual scaffolding. Connecting the city’s possible futures to an array of intensive production processes, and to actual extensive and qualitative spaces, it monitors spatial change and contingency. The apparatus stands for a topological approach to spatial

> dynamics, a complex model of predictability, where the term "model" concerns an extended model that calculates becomings and mutations.

In the case of the apparatus designed for space, its dimensions will be assigned values based on the relevant ways that *the city* can change while the points in the manifold will represent all the possible states the city can have. Following this as a making-agenda for the city's "state space", we shall attempt to better define the apparatus in terms of its *dimensionality and structure* returning to the manifolds' more scientific background. The apparatus — a multiplicity to be modelled into a manifold — is an N-dimensional topological surface, its number of dimensions being equivalent to the relevant ways the city can change, the variables or coordinates upon which it depends. The elements of the multiplicity or spaces in the manifold, represent all the possibilities for a given system, or in the case of the apparatus, all the sociospatial possibilities of the city.

By now, we have a much clearer idea of how a manifold for the city looks like and how it is expected to behave. At the same time, we know more about its components or elements regarding their optimal character and structure. As we move forward in designing the apparatus, for the version presented here, we shall focus on the production of multiplicities as presented by philosopher and researcher Daniel W.Smith, in his essay " 'A life of Pure Immanence': Deleuze's 'Critique et Clinique' Project" (Smith, 2012, p.189-221). His focus in this essay is on the Deleuzian concept of Life as a non-organic and impersonal power while the production of the multiple, according to Smith, entails two tasks: to *obtain pure singularities* and *establish relations or syntheses between them,* so as to produce a variable whole that would be the ''effect" of its disconnected parts (Smith, 2012, p.198). For the former task, *a power of abstraction* is extracting or producing such genetic elements while at the same time placing them in a state of continuous variation. After the end of this process, each Design Pattern is designed as an N-dimensional manifold, the dimensions corresponding to the variables of its extensive and intensive properties. At the same time, a set of 88 intensive variables are extracted from Design Patterns to become the apparatus' elements. For the latter task, *a power of invention* is creating ever new relations between these genetic elements (Smith, 2012, p.218). After the end of this

process, the manifold's elements interconnect to exhibit the full repertoire of their communicational tendencies and capacities.

A Power of Abstraction: From Design Patterns to Intensive Variables

To move away from the city's metric spaces of extensive and qualitative properties and thus move closer to its potentialities of becoming — its tendencies and capacities — we first need to tap into the city's intensive realm. To that end, *intensive parameters* that define the city's important "ways of changing" are thoroughly examined and mapped. Focusing on Alexander's initial archive, each invariant Pattern is evaluated in terms of *its extensive and intensive properties*. Pointing to each Pattern's problem analysis and solution — for which Alexander provides a guideline and a visual diagram — *a set of variables* is extracted from each Pattern. The variables are each Pattern's "ways of changing", the structure of its N-dimensional surface or manifold. These parameters are intensive ordinates to be construed as *processes*, that is, not as adjectives or nouns but as verbs or infinitives (Sha, 2013, p.148) (Fig.05). For example Design Pattern "8.mosaic of subcultures", has several parameters pointing to its generation such as *spatial demarcation* or *character*. They are to be thought of as *to spatially demarcate* or *have/enable a character*, pointing to their internal conditionality and textured internal structure. Through such an extraction process, each Pattern establishes its degrees of freedom — the variables responsible for its actualisation — and is advocated for as an *assemblage of variables*. The variables map the textured gradients of each Pattern's becoming, its phase or state space. After the end of this process each Design Pattern possesses a definite dimensionality, that is, a specific number of relevant ways of changing while the population of Patterns is dimensionally heterogeneous. Through this process, a total of *88 variables* have been extracted or sampled from Alexander's Design Patterns and a list connecting them with their respective Patterns is produced. Through this list, each intensive variable is associated with the Design Patterns responsible for its actualisation. After the end of this process, intensive variables have been extracted from the city's extensive and intensive unfoldings.

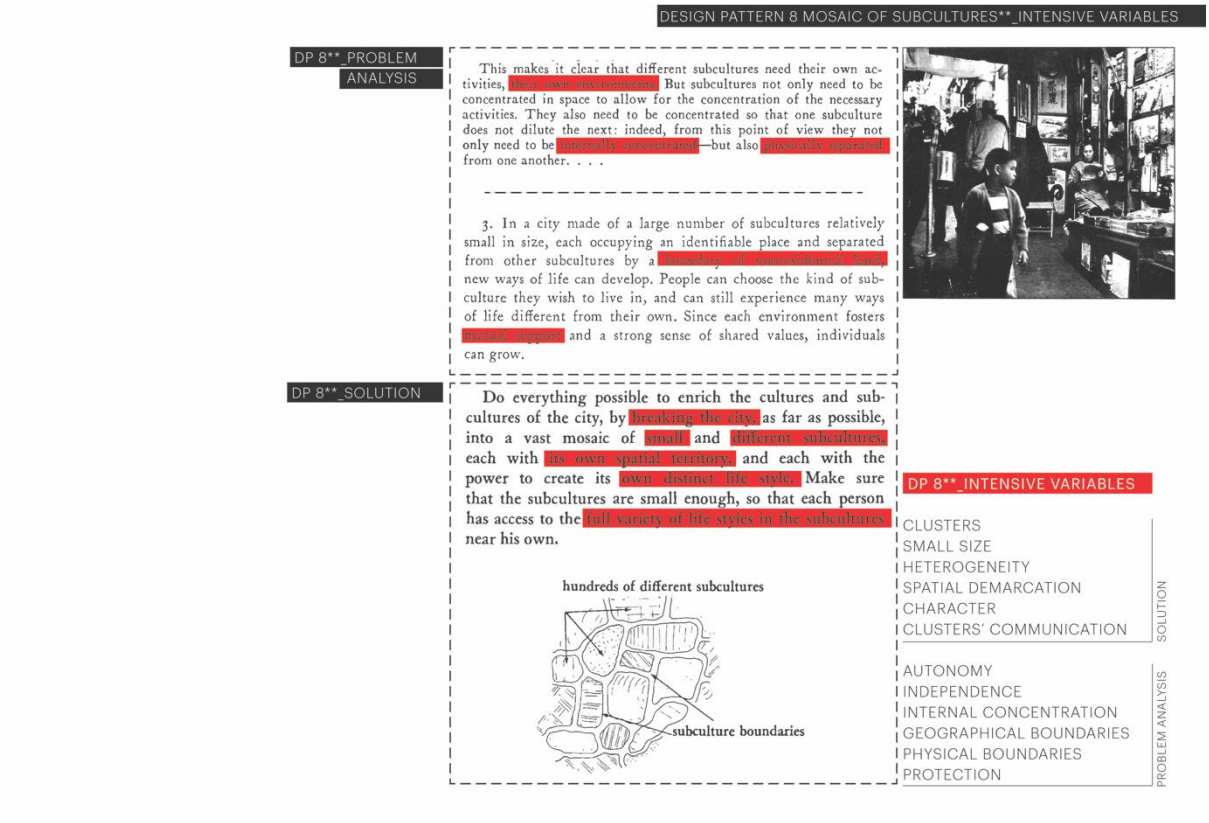

Figure 05. Design Pattern 8 Mosaic of subcultures**_ Intensive Variables (Passia Y. and Roupas P., 2021)

Intensive variables or "intensive ordinates" (Deleuze, G., and Guattari, F. (1994), p.20) become the *apparatus's elements* and are introduced onto a surface in space attributed solely to their productive relationships, interactions, negotiations, and exchanges (Fig.06). On that surface, they are free to assemble and reassemble anew, live or die, vary at different speeds and rhythms, as they exercise their communication properties, they exhibit their unactualized tendencies and manifest their full range of capacities. This surface, an N-dimensional manifold, assembles spaces of heterogeneous dimensionalities, allowing them to co-exist and should be construed *as a plane of variable dimensionality.* Furthermore, its heterogeneous population is itself N-dimensional as each Design Pattern has been restructured as an assemblage of intensive variables, its dimensions, or coordinates. The apparatus' substratum is by now a vectorial field of connectedness itself composed of nested vectorial fields of connectedness. The speeds and rhythms of each element's variable structure and discrete dimensionality reciprocally define the apparatus while allowing for its continuity. As Deleuze writes (as quoted by DeLanda):

> Far from reducing the multiplicities' number of dimensions to two, the plane of consistency cuts across them all, intersects them in order to bring into coexistence any number of multiplicities, with any number of dimensions. (DeLanda, 2005, p.112)

Through such a "power of abstraction" an array of "genetic elements" has been obtained from Design Patterns, parameters that define important aspects of spatial behaviour. At the same time, each element construed as an individual process has been placed in continuous variation. As variables are wired to their respective Patterns, a set of Design Patterns becomes affiliated to each variable pointing to its affective capacity. At the same time, on this plane or field, spatial variables "can address each other and can be used by us to make claims, propositions, hypotheses, arguments" (Grosz, 2018, p.136). Through the abstraction process, the apparatus approaches materiality and materialised networks on the basis of continuity between the city's actual and possible entities, their properties, tendencies, and capacities (DeLanda, 2013, p.66). It articulates the city's complexity by intensively mapping its affective subspaces along with the patterns and thresholds of their behaviour. New cartographical maps offer a scaffolded approach to the city's most significant morphogenetic movements, those that drive its actualisation patterns.

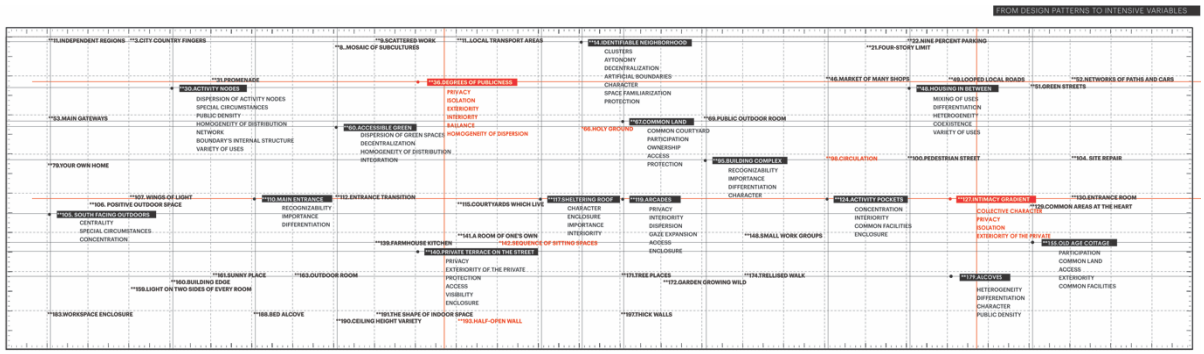

Figure 06. From Design Patterns to intensive variables (Passia Y. and Roupas P., 2021)

A Power of Creation: The Manifold's Architecture

To elaborate on how entities contribute to the becomings of one another, affording and constraining possibilities of movement and interaction, the manifold's

architecture is further designed. For this part, we shall rely on the *"power of creation*" capable of inventing ever-new relations between these differential or genetic elements" (Smith, 2012, p.218). In this framework, we articulate the *manifold's architecture* defined by the multiplicity and connectivity patterns of its local spaces or elements, the *intensive variables,* and the ways of connecting these spaces in an infinite number of ways. As Bennett points out, "matter has an inclination to make connections and form networks of relations with varying degrees of stability" (Bennet, 2004, p.354). The manifold's architecture establishes a system of communication between the elements of the multiplicity that until now have been non-communicating. Networked maps of the entities' mutual communication articulate their proximity and relatedness, as well as the "polydimensionality of their control mechanisms" (Galloway, 2007, p.67). Operationalising the extraction list, intensive variables interconnect on the basis of their affiliated Design Patterns as the manifold's connectionist structure is being gradually defined (Fig.07). The manifold's dynamic landscape consists of a nexus of communication patterns between its elements, mapped by means of networks of interconnected nodes.

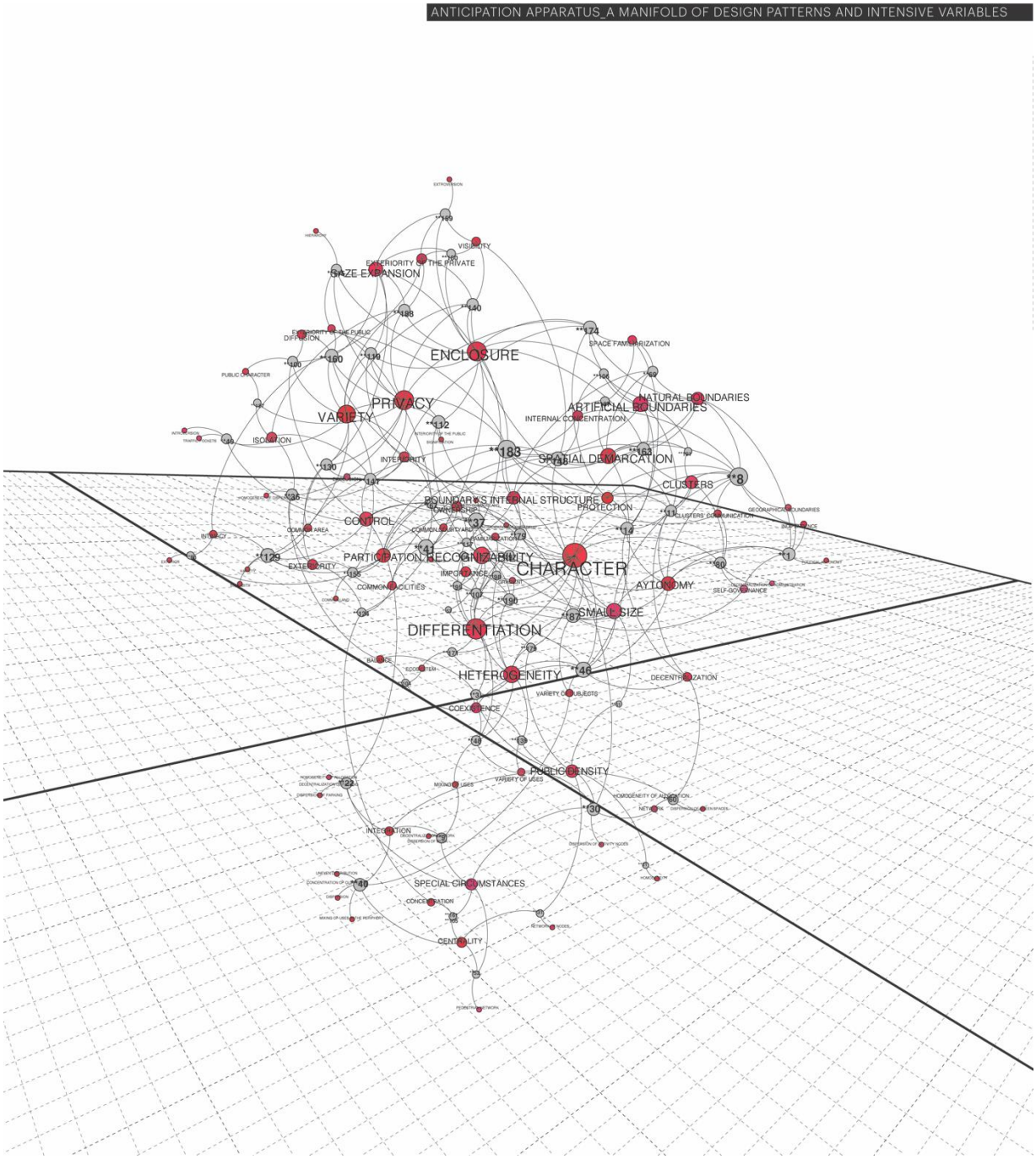

Figure 07. Anticipation apparatus_ A manifold of Design Patterns and intensive variables (Passia Y. and Roupas P., 2021)

Networks are controlled by protocols — the Design Patterns — and set the system's patterns of behaviour as well as the intensive boundaries where the system changes patterns, it's attractors and bifurcations respectively. The manifold's network topology consists of *nodes and connections*. Nodes are points or spaces in the manifold

representing its entities while connections are lines that relate any two such nodes with one another and define the entities' pattern of relation. Nodes and their patterns of connection constitute the manifold's form which in turn enables the manifold's function: "the speed by which certain elements flow from point to point, the kind of actions that networks find easier to perform" (Lury, Parisi and Terranova, 2012, p.19). In the apparatus, all active connections between entities are mediated by the Design Patterns, themselves nodal points on the topological surface. Nodes are multidimensional structures. They "by no means have contours that are defined once and for all but are chains of variables that are torn from each other" (Deleuze, 2007, p.343). *Connections* are fragile and precarious. As Deleuze, notes:

> "lines of different natures follow directions, trace processes that are always out of balance, that sometimes move closer together and sometimes farther away. Each line is broken, subject to changes in direction, bifurcating and forked, and subjected to derivations." (Deleuze, 2007, p.345)

The apparatus now resembles "a relational field of emergence" (Parisi, 2012) on which space is perceived as "assemblages of variables" and specific Design Patterns are correlated to its socio-spatial production processes. In the manifold's topological surface one can specify neighbourhoods of continuity, connectedness, and sameness in terms of fields of vectors and vectorial gradients **(**Lury, Parisi and Terranova, 2012, p.23) without having to use rigid lengths or metric quantities. The manifold's architecture establishes a system of communication between the elements of the multiplicity that until now have been non-communicating. What is of essence here are not the manifold's elements but what is between, a set of relations which are not separable from each other (Deleuze and Parnet, 1987, viii). This setting up of spaces in the manifold reintroduces the concepts of *continuity and qualitative properties* in articulating actual spaces and their possibility for change. Networked maps of the entities' mutual communication articulate their proximity and relatedness in structuring space.

Conclusion

The anticipation apparatus reconceptualizes the built environment as living continua in constant variation, mapping “objects that come into being, as they emerge from continuous and continuously varying fields of media-material and then dissolve again into those fields” (Sha, 2013, p.90). Through the apparatus, it is possible to explain how space changes in relation to networked patterns of communication between its elements, themselves variable entities. At the same time, it articulates *space as a field of connectedness composed of nested fields of connectedness* where change can be perceived as immanent and relational while space itself becomes fully intensive. Constructing new cartographies of diagrammatic connections of both existing and possible objects, the manifold is actively marking spatial and social continuities, similarities and connectivities. The concept of spatial assemblage is not only endowed with parameters — the city’s intensive variables — but now evolving as they interact with real-time data. The manifold becomes “a topological engine of potentialities”, a differential field of potential transformations that anticipates its affective becomings (Parisi, 2012, p.176).

Thinking and designing through topological media rejects traditional architectural objects, being propositional of how their staticity, irreversibility, and most importantly discontinuity can be overcome. Replacing actual spaces with the intensive variables responsible for their actualisation allows us to conceptually acknowledge those spaces as variable entities while at the same time mapping their capacities for sociospatial change. On the topological surface of the manifold, intensive variables of actual spaces are now able to communicate with other intensive variables, existing or possible, distant or proximal, “free or at least agnostic with respect to measure, metric, counting, finitude, formal logic, syntax, grammar, digitality, and computability, in short free of the formal structures that would put a cage over all of the lifeworld” (Sha, 2012, abstract). More importantly, as intensive spatial variables remain genetically connected to their respective Design Patterns on the manifold, it is possible to design concrete yet abstract actualisations. Thus, granting architectural objects their virtuality back even after the point of their actualisation.

The apparatus is operationalised for the design of ontologically unstable, intensive, and ecological spatial assemblages. Also, capitalising on the apparatus' continuity and connectivity, it has the ability to radically modify — multiply, intensify, diminish or invert — existing spatial assemblages, their components or their respective connections. In articulating the city's auto-generative dynamics, control has been replaced by an anticipation apparatus, a prediction machine that computes appearances and uncertainties via intensive pattern recognition, differential relations, and continual variations. An urban ecology of sociospatial continuities of forces and matter integrated into a single envelope: an intensive manifold whose existing and emergent neighbourhoods can be activated in any number of ways (Parisi, 2012, p.179). More than a merely aesthetic experience, the city is here understood and designed as the matrix of the topological forces that formulate it, its different actors coming into play, their territories constantly in the making.

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