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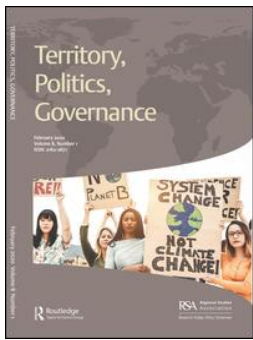
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Urban crystallization and the morphogenesis of urban territories

Andrea Mubi Brighenti ^a and Mattias Kärrholm ^b

ABSTRACT

We develop the perspective of crystallization as a way to shed a light on the morphogenesis and stabilization of urban territories. We start by describing crystallization as a consolidation of a visible and singular order that establishes certain privileged directions of growth and breaks spatial and temporal symmetries. We then illuminate how crystallization processes unfold at different scales, going through a series of historical cases, from the stabilization of urban regions, to iconic places such as Times Square, New York, and on to large scale linear or path crystals, such the Turia Riverbed Park in Valencia building on these cases, we then discuss crystallization as a phenomenon requiring metastability, and how this metastability relates to different ways and forms of territorial stabilization. Finally, we discuss how crystallization, by making certain figures and directions more salient than others, also plays an important part in the emergence of new scales and in the processes of urban rescaling, that is, how crystallization also contributes to a hierarchical segmentation of the urban environment.

KEYWORDS

urban development; urban environments; urban morphogenesis; crystallization; scale; territorial stabilization

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INTRODUCTION

We explore and theorize the phenomenon of urban crystallization. In particular, we propose to interpret crystallization as the establishment of local-level, and even urban-level, formative processes within a territory. More specifically, crystallization entails a gain-in-order within an emerging urban form that helps to coalesce and stabilize several affordances provided by a given urban environment. Crystallization can be defined as a structured process of growth, where form and its associations develop in an accumulative and ordered, yet not fully predetermined, way. An urban crystallization can thus be seen as a type of *territorial stabilization* (Kärrholm, 2007). In general, stabilization has to do with the becoming-cohesive – although not necessarily purposeful – of a territory, a movement that makes the territory both more homogeneous and more distinctive, making its associations to certain practices and certain actors firmer. Proceeding this way,

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stabilization always accompany morphogenesis, or the process through which a territory *takes form* under given energetic regimes and within given environmental relations.

To clarify the notion of crystallization, some cursory digressions through physics and chemistry will be necessary. Yet, in essence, the main idea is that, while certainly not entirely new, the crystal image highlights some aspects that remain in the blind spot of most studies of cities and the governance of territories. We should also remark that this paper is framed as a theoretical invitation – an ‘as-we-may-think’ piece – and its claims are heuristic more than conclusive. In particular, in the examples discussed below, we can only hint at the significant social–spatial and historical contexts, but we have no space to reconstruct in detail the specific human and ecological energetic regimes that gave rise to the considered crystallizations. However, while urban and regional studies have advanced wonderfully over the last 20 years or so, some dissatisfactions remain as concerns the sociological and spatial imagination that is being deployed. Since the 1990s, for instance, ‘networks’ have been added to more traditionally understood ‘territories’, and the interplays between territories and networks have been amply investigated. Similarly, the crystal could now be added as a further image to appreciate the life and the becoming of territories.

Crystallization is aligned with stabilization. It is, however, not simply a matter of order, but also, inherently, a matter of *perception* of the given order. Not simply does the crystal enhance the legibility and recognizability of an urban form, urban scenery or view, but order itself is entangled with perception and co-constituted with it. Crystals are always crystals of visibility, or crystallized visibility, that is, visibility made pregnant with meaning.

If the crystal thus signals the advent of a visible order, it is because such order is, so to speak, ‘written in the visible’. In a sustained way, visibility speaks first of all of the public nature of cities, of their being before everybody’s eyes (Brighenti, 2010). Even the corrosion of a crystal – for instance, with acid – is an orderly process in that it produces ‘negative crystals’ of dissolved materials in the main body. On the other hand, under changed parameters of the environment, the crystal may also simply melt spontaneously: this means that crystallization is not an end reality, or an irreversible one – and this aspect may be of significance when examining urban realities.

As soon as we evoke acts such as acts of writing or inscribing some pattern of order in ‘the visible’, we realize that an adequate *temporal* horizon is pivotal. Not only is crystallization a temporal process itself, but also it is related to a special temporal form. Walter Benjamin introduced the expression ‘now of recognizability’ (*Jetzt der Erkennbarkeit*):¹ he saw such a peculiar temporality at play in what he famously designated as ‘dialectical images’ – images fraught with tensions and contradictions, suspended between different temporal orders, which simultaneously could be revelatory of the ‘signature’ of a specific epoch. The now of recognizability is related to the type of perception a given environment affords. These environments were, for Benjamin, mostly historical, social and cultural, but we believe that a similar gaze can be fruitfully extended to urban realities at large. In 1929 Benjamin elsewhere dubbed ‘profane illumination’ (Benjamin, 2005, p. 209) the continuation of traditional religious spiritual awakening in the context of avant-garde art, and more specifically the peculiar encounters of Surrealist authors and painters with the layered yet immediate, enigmatic temporality of urban space. In both cases, a special legibility of an order bursts out and comes to the foreground, outside of the usual coordination of space and linearity of time.²

Benjamin’s evocative and yet somewhat obscure formulas point to a relational understanding of time and space; to researchers in territoriology, they might recall, for instance, the process of ‘territorial sorting’, that is, an associational, and even reputational, form of territorialization whereby certain territories come to be associated, in the public perception, with certain actors, certain activities and certain rhythms (Kärrholm, 2007, 2012; Tonnelat, 2013). Here we adapt similar insights to cities, suggesting that one of the main payoffs of employing the crystallization notion in urban analysis is a critique of both evolutionism (linear sequences of development) and

dualism (dichotomy between objective fact and subjective perception) in our understanding of the urban process. Crystallization stabilizes not only physical space and the built environment but also, concurrently, perception and spatial experience. Through crystallization, the material and energetic set-up and the perceptual–affective experience converge towards a ‘zone of indistinction’: functioning as a stabilizing device, the crystal inherently provides new perceptual experience – a peculiar *take on the city*.

To begin, crystallization presents the following peculiarities:

- (1) Crystallization entails phase transition, which occurs around critical points where transformation manifests itself at accelerated pace.
- (2) The crystal offers the simple prototype of an individual entity, or singularized environment – the crystal is, in a sense, a uniquely formed, distinct individual; concurrently, crystallizing can be regarded as the inception of a process of individuation.
- (3) The coming about of a crystal requires the meeting of a microscopic ‘germ’, functioning as a structuring principle, with a ‘solution’ in a special energetic state of metastability – such as, for instance, oversaturation, which engenders far-from equilibrium dynamics where the potential energy of the solution is made available to the structuring operation.
- (4) The crystal is a rhythmic creature: presenting recurrent features in time and/or space, it allows for some predictability of outcome, although always partial and never thoroughly deterministic.
- (5) Crystal growth represents a specific type of growth that breaks spatial and temporal symmetries, exhibits privileged directions, and presents us with polarization characteristics similar to those of life.
- (6) Once considered as a peculiar type of life, the crystal offers a model of non-organic life, that is, organ-less, decentred or a-centric life.
- (7) As a specific type of perception, crystalline perception establishes contact with ‘bare time’, rather than ‘action time’ (with Bergson, 1939/1993, pure memory rather than movement-images) – in other words, crystallized perception corresponds to the immediacy of purely optical–aural images, as opposed to natural movement-images.³

Processes of crystallization in human social territories can be recorded at various spatial scales. More than this, urban crystallization is inherently a multi-scalar phenomenon. Here in particular, we explore a variety of scales ranging from *room* to *local*, as well as from *path* to *urban landscape*. In this sense, we observe how a particular room type (such as a living room), a recognizable locale (such as an urban block), a given path (such as a daily commute), and a whole urban system (such as a city or urban landscape) could all crystallize. We seek to clarify under which conditions this happens, and with what consequences. Moving across scales, and comparing them, we are also led to ascertain the potential for *trans-scalar* crystallizations. This entails considering the relation of the city to, on the hand, the smaller elements inside it, and, on the other, the larger regions and spatial formations outside of it.

While there are no hard edges around or between scales, on particular occasions certain figures at a given scale may become more salient – and more pregnant – than others. This might be an important factor in establishing certain ‘measures’ of urban life. The importance of this lies in the fact that, by producing and being subjected to measures, the urban domain gives shape to socioeconomic and ethical–political hierarchies. Below, we return to this point and unpack some of its implications. For now, suffice to assert that public attention towards certain scales may change over time, as certain neighbourhoods, districts, cities or urban landscapes undergo phase transitions. Scalar shift might, in this way, may act as the harbinger of new crystallization processes to come.

The remainder of the paper is structured as follows. In the next section we further clarify our view on crystallization by relating it to the more well-known notion of urban agglomerations and clusters. In the third section we set the frame for our discussion by reviewing some classical thinkers dealing with regional stabilization and city clustering, including Walter Christaller, Victor Gruen and Gabriel Dupuy. In the following sections a series of historical cases help to illuminate urban crystallization processes unfolding at different scales, including interior rooms and room types (the fourth section), public places such as Times Square in New York, linear or path crystals such the Turia Riverbed Park in Valencia, and the High Line Park in New York (the fifth and sixth sections). The case discussions end with an outlook on the city as a whole from the perspective of crystallization (the seventh section). In the final section we move to an analytical discussion of crystallization as a phenomenon requiring metastability and relating to different ways and forms of territorial stabilization. Here, we discuss how crystallization, by making certain figures and directions more salient or more pregnant, also plays an important part in the emergence of urban rescaling. Finally, an example of trans-scalar crystallization is also considered, hinting at further morphogenetic possibilities.

CRYSTALLIZATION AND URBAN AGGLOMERATION

Before turning to examine various scalar levels, in order to obtain a clearer grasp of the phase transitions capable of determining crystallization, it is necessary to spend a moment on how the notion of crystallization relates to the attested models of urban agglomeration and clustering.⁴ Agglomeration and crystallization have an affinity, but their overlap is only partially: the difference of emphasis suggests it is better to keep them as distinct notions. First, urban agglomerations are usually theorized and discussed at large scale only. There is a tendency towards tackling – as well as a fascination for – gigantism that becomes palpable in the literature, especially since Jean Gottmann's megalopolis notion. In this respect, the notion of crystallization could draw attention to multiscalar and fractal relations of urbanization that are not much visible in the agglomeration literature.

Second, urban agglomeration studies tend to focus on issues of connectivity among the nodes – sometimes analysed in terms of 'integration'. A network-centric approach clearly dominates these studies. For their part, crystals also exhibit network formations and network properties (the crystalline lattice); however, the process of crystallization may also find itself contradicting the dynamics of urban agglomeration as they take place on the ground: especially where urban development is rapid and chaotic, one does not have any detectable crystallization. Instead other forms of connectivity may prevail – such as, for instance, fluid topologies in Mol and Law's (1994) sense. The peculiarities of crystallization can be noticed in not only space, but also time – specifically, in the *rhythms* afforded by crystallization. Indeed, crystallization processes sustain certain rhythms of action and perception that are more restricted than the range of rhythms hosted by agglomerations – in this sense, crystallization appears more specific than agglomeration.

Third, urban agglomeration studies tend to approach density as a continuous territorial variable, which may increase (densification) or decrease (de-densification). Instead, crystallization brings to the foreground the issue of discontinuity between different urban states – or phase transition: a more complex dynamic of continuity and discontinuity can be recognized, whereby small quantitative changes may bring about a whole qualitative transformation of an urban configuration. The critical thresholds between phases become a crucial locus for urban crystallization studies.

Fourth, attending crystallization enables research to focus on the moving boundary between different urban states, shifting from *form* to *formative processes* in the making – that is, to morphogenesis. If we accept Fang and Yu's (2017, p. 132) point that, 'since an urban agglomeration

is supposed to be a dynamic concept, a fuzzy boundary is most likely more appropriate', then we suggest that crystallization nicely complements the urban agglomeration literature, by focusing precisely on the *evolving boundary-conditions* of an agglomeration – and, here again, the multiplication of relevant scales entails that crystallization does not only occur *at the outer limit* of the urban agglomeration, but may as well take place in some of its inner interstices.

CRYSTALLIZING URBAN LANDSCAPES

In the 1930s, in his central-place theory, the German geographer Walter Christaller (Christaller, 1933) argued that single villages and other settlements could become crystallization points for a regional landscape – an idea that was further developed by August Lösch (Lösch, 1940; Wilson, 2000, pp. 54ff., 134ff.). On the other side of the Atlantic, at nearly the same time, Lewis Mumford (Mumford, 1938) made a different observation. He noted how the new highways around New Jersey were as isolated from the countryside as they were from major urban centres. Mumford concluded that 'no single center will, like the metropolis of old, become the focal point of all regional advantages: on the contrary, *"the whole region" becomes open for settlement*' (p. 489; original emphasis). Such is, precisely, the movement towards suburban sprawl that has famously contradistinguished the second half of the 20th century. So, while Christaller's theory seems to foreground the notion of centrality and central-peripheral relations, Mumford's observations diagnosed the rise of a potentially acentric, yet patterned, suburban landscape.

In the 1950s, the Austrian exile and naturalized American architect Victor Gruen (Gruen, 2017) conceived of the shopping mall as a new building type that could induce the crystallization of a whole amorphous suburban landscape. Gruen started from the assumption that the American suburb was deficient in urbanity: it lacked structure and fibre. What Gruen called the regional shopping centre had as its core mission to 'create environmental qualities that will help fulfil the human heart's desire in the city's heart' (Gruen, 1973, p. 299). Such a vision, rooted in Gruen's own personal nostalgia for his hometown city of Vienna, underpinned his life-long mission to bring a traditional sense of urbanity ('the city's heart') into the new, largely motorized urban regions, at the new urban scale that was being developed throughout the Western countries.

According to Gruen, certain crystallization points should be inserted into the sprawling landscape to give it structure and direction (see point 5 above: the crystal breaks symmetries and initiates a vectored growth). Certainly, the mall provided a type of crystallization quite different from the one Christaller had in mind. The power of history is clearly very different in the two models: dominant in Christaller, ancillary in Gruen. Gabriel Dupuy (Dupuy, 2008, p. 53) has remarked in this respect that, since the aftermath of the Second World War, a significant inversion of Christaller's model has, in fact, occurred. With the increasing dependency on network infrastructures such as electricity, the telephone, television and the car, the arrow no longer goes from node to territorial stabilization; on the contrary, it is now the geometry of the grid and the topology of its linkages that dictate where the nodes will next appear. It was this paradigmatic shift that Gruen somehow recognized and addressed, with the shopping mall conceived as a measure to counterbalance the centrifugal free rein of suburban sprawl. Retrospectively, in the late 1970s, Gruen himself admitted that this invention later became so dangerously successful that, instead of bringing the crystal germ of urban life into the suburban land, it now menaced the very survival of cities – especially in the case of so many North American struggling urban inner cores.

Habraken (1998, pp. 43ff.) similarly indicates the post-war period as a game changer in the relation between crystallized forms established at the urban level and the built environment inside the city. In early modern Europe – as in many other parts of the world – large urban infrastructures such as pavings, sewers, sidewalks, were often lagging behind buildings. New buildings and

even palaces were built on unpaved streets, often in the middle of nowhere. Connections would follow, not rarely through sheer usage, without planning. Instead, since after the Second World War, urban infrastructure necessarily had to precede buildings: the urban network has crystallized in asphalt, concrete, granite, pipeline, electricity grid, etc., to which the built structures could subsequently be added and linked. The development of modern urban planning is intertwined with this new distribution of crystallized urban parts in space.

The very possibility of crystallizing new land into urban forms changed its pace with the advent of new production techniques, new construction materials and new building technologies: this trend has been going on at least since the second half of the 19th century when the first great infrastructures of mobility were implemented. Suffice to recall the role of railroad companies in the American West since the 1860s: these companies quickly and cheaply laid out hundreds of towns along their tracks, based on standard grids of about 30–60 urban blocks. By doing so, they generated enormous land speculation even before proprietors and real estate entrepreneurs could get into the game (Kostof, 1992). In the conclusions, we return to the connection between crystallization and capitalization of urban land. But now, we shift to the other scalar extreme to be examined: the room.

CRYSTALLIZING ROOMS

Although crystallization can take on vast scales, it can also start with more modest ways such as rooms and sub-building spaces. A room is basically a way of providing space to certain people and certain undertakings. Features such as size, orientation, entrances, windows, furniture and social uses are not historically stable, and indeed have varied significantly over time. However, within certain limits of variation, a room type remains clearly recognizable and can be studied on the basis of its name and design (Markus & Cameron, 2002). As has been noted by architectural researchers, in early modern Europe room types were not often use specific (Habraken, 1998). Vernacular homes were, for example, often subdivided into more general room types, such as atriums, chambers, halls, cellars and attics, where room names were related to the room's size or position in the house (Rybczynski, 1986, p. 42). Even at Versailles, where the design of space was luscious and elaborate, predefined uses or functional programmes were few: 'People populated Versailles's vast halls as they would have populated a landscape, strategically positioning themselves and their furniture to claim and domesticate it and accompanied by no less strategic gestures and language' (Habraken, 1998, p. 134). The order in which rooms followed one another was more stable than rooms themselves, producing a kind of linear crystallization in house after house. We return on this point below in a discussion of path crystallization; here we notice how, with reference to our point 4 above, crystallization produces a spatial rhythm that facilitates predictability of spatial arrangements. For example, the entrance of the Dutch canal house was structured 'via a *stoop*, bypassing the protruding *pothuis* (basement extension). The front door opens into a *vorzaal* ... [etc.]' (p. 279).

It has been documented how new room types proliferated throughout the 19th century, often categorized in relation to class, gender and/or use (Markus & Cameron, 2002, p. 49). The prime example of this era is Britain, where the so-called hall-plan, that is, all rooms centred around the hall, led to the proliferation of corridors and passages connecting the hall to other rooms. As Muthesius (1979, p. 91) has noted, the hall is here 'the key to the whole plan of the house'. In our terms, this 'key' can be addressed as the crystal germ capable of precipitating a whole new territorial mode (see point 3 above). In Britain, much more than on the continent, rooms only had one door, which could only be accessed through either the passage or the hall. The proliferation of passages, allowing for neutral leeway between rooms, also opened for a far-reaching specialization of room types (Evans, 1978), establishing certain patterns of spatial expansion that are striking in the Victorian country house (Girouard, 1979; Muthesius, 1979, pp. 79ff.). It is in

this sense that the hall and corridor plan initiated a specific type of architectural crystallization during the 19th century (cf. Steadman, 2014, pp. 39ff.)

During the 20th century, the notion of effective use rose to become a dominant principle of categorization. If we look in particular at residential room types, the 1950s seemed to be marked by a general numerical decrease (Kärrholm, 2020). The home of industrialized regions grew increasingly stabilized as a place of privacy, comfort and retreat, but also of functional efficiency, where increasingly standardized furniture was placed (Costantino, 2015). Since then, applied research on room types has focused on the design of kitchens that were easy to work in, toilets that were easy to clean, etc. Together with the decrease in the number of room types, this efficiency-oriented design approach also paved the way for the crystallization of the ‘apartment’ house comprising a set of obligatory room types (basically, bedroom, kitchen, bathroom and living room).

The home became a type produced, as it has been said, ‘from a standard “kit of parts”’ (Steadman, 2014, p. 358). This is perhaps especially apparent in countries such as Sweden, where standardization was pushed quite far. During the 1960s and 1970s, the names of residential room types, started to disappear from the architectural plans featured in *Arkitektur*, the most important Swedish architectural journal. Since the room types of apartments were so few, and more importantly repeated from house to house, year after year, there was no longer any need to mark them out. Eventually, in the early 1990s, the Swedish building standard for room sizes was abandoned and the building code no longer dictated a detailed prescription for the layout of housing plans. This in turn opened up both for a new fluidity of usages in connection to newly emerging domestic social uses, activities and technologies (where, for example, the kitchen and living room became increasingly integrated), and for the appearance and reappearance of new and not so new room crystallizations (such as, for instance, the spa and the parlour).

CRYSTALLIZING LOCALES

At another scale, urban locales can also crystallize and melt. According to the classic Aristotelian thesis, cities initially formed by the merging of proximal villages – a process known as *synœcism* (Kostof, 1992, p. 59). This explains in part the enduring significance of structural elements such as parishes, neighbourhoods, communities, *contrade* and hamlets within urban contexts. However, this does not mean that locales are unalterable. An interesting case of crystal dissolution is offered by Panerai et al. (2004) who argue that the Haussmannization of Paris led to the progressive demise of the urban block itself.

In the mid-19th century, Baron Haussmann’s urbanism profoundly transformed the function of the block: breaking with earlier pre-industrial traditions of mixed use, and excluding from the locale both the multiplicity of everyday facilities as well as public monuments and institutions, Haussmann created single-function (typically, residential) blocks (see also Sennett, 2019). Haussmann’s operation became a blueprint largely copied across Europe in the late 19th century. In H. P. Berlage’s early 1900s’ plan for the Amsterdam extension, for instance, the block was treated as a single unit rather than as an assemblage of buildings, and single buildings were required to adjust their facades to subsume to a dominant, unified aesthetic idea (Habraken, 1998, p. 84; Panerai et al., 2004, ch. 3).

With Ernst May’s Frankfurt plan, dating from 1925 to 1930, the single-slab buildings broke up the close courtyards, occupying the whole width of the block. At this point the block became ‘only an accidental element’ (Panerai et al., 2004, p. 157), which was dissolved with Le Corbusier’s *Unités d’habitation* (first conceived c.1920, then built in Marseille in 1947–52). In fact, the *Unités*’ design disregards the principles of front and back, and (to some extent) even the distinction between floors. This explains why, as hinted above, the dissolution of the block structure has

brought urban networks to the foreground as the primary crystallizing germs in urban development.

Modernist architects placed high hopes on the crystallizing powers of their projects. Bruno Taut, for example, seems to have harboured the dream of a perfect crystallization in his book *City Crown* (1919). The city crown is specifically described by Taut as a huge urban monument: 'a crystal house reigns over all like a glittering diamond' (Taut, 1919/1975, p. 85). This crystal is placed as the 'crown' of the city on top of a cross formed by four large intersecting buildings. These buildings, in turn, house public functions in different zones where 'architecture becomes a crystallized image of the strata of man' (p. 84). With reference to our point 6 above, Taut's vision seems to clearly evoke for the city the status of non-organic life form.

As discussed above, Gruen was concerned with establishing crystallization points in a directionless urban sprawl, so as to precipitate the conditions associated with urban lifestyle. But crystals can also develop out of already existing urban structures and conditions. One outstanding example of this is Times Square in New York. Berman (2009, pp. 108f.) says that after the introduction of electric networks, the theatres of Broadway were plugged during the 1890s. The electric signs were then restricted in the area and focused on Times Square. With the opening of Times Tower and the New York city subway in 1904–05, together with a court rule in 1909 that overturned a law regulating the size of electric signs, 'this vibrant city neighbourhood made a kind of quantum leap and became a hyper-city neighbourhood' (p. xxi). Times Square soon became noted for its abundance of big signs, illumination and large crowds enjoying the urban spectacle.

The 'quantum leap' mentioned by Berman is precisely a phase shift or phase transition in the sense described above (see point 1 above). The crystal can thus also connect to a form of spectacular, or better spectacularizable, visibility: due to its compelling geometry, it is naturally made to command attention. So, the iconic Times Square hyper-place offered a crystallization of the society of spectacle, symbolizing not only New York but perhaps also America itself: 'How Americans feel about Times Square ... often depends on how ready they are for a liquefaction of their being' (p. 39). Drawing from the classic observations by Karl Marx about the collapse of the medieval social order with the advent of the modern bourgeoisie, Berman places himself in the tradition of the analysts of modernity-as-melting. Yet paradoxically, the potentials for this modern experiential 'liquefaction' is derived from the presence of a strongly individualized local urban crystal. Indeed, as recalled at the outset (see point 2 above), since the crystal is more specific than the amorphous state, it also provides a basic instance of spatial individuation.

Times Square is a temple, in the same sense in which Benjamin (1999) called the Parisian arcades 'temples of commodity capital' (p. 37). But, while the arcade constituted a typology (Geist, 1983), at least in principle potentially replicable (although still retaining a noticeable degree of individuality – as attested by the evocative power of names such as the Passage des Panoramas or Passage Choiseul), Times Square is definitely singular and irreplaceable – to the point that Berman can write a biography of it. We are thus led back to our initial stipulations: as crystallization marks the inception of individuation, the emergence of an individual identity, or singularized environment, urban crystals produce unique solutions to the urban process: this way, Benjamin's 'now of recognisability' can be hosted in space.

CRYSTALLIZING PATHS

In the classic analysis by Foucault (2004), biopolitics is a type of governance that evolved for the management of the open space of flows in the city. As older crystallizations melt and new ones coalesce, a vast array of trajectories comes to be inscribed into the modern urban fabric. One such form that emerged from the gradual crisis of the classic urban block was, for instance, the 'linear city', theorized by Arturo Soria y Mata c.1882. Soria, who was trained as a civil engineer, conceived a city that would run along a river, or similar longitudinal mark, hosting functionally

specialized parallel sectors, with an emphasis on an overarching directionality (see point 5 above). Since the 1920s, the *urban strip* was indeed introduced as a road lined up on both sides with car-oriented services, such as gas stations and diners. It also became known informally among planners as the ‘hot-dog trail’ (Hayden, 2004, p. 98). The urban strip emphasizes the tensional relation between settlement and mobility, underlining the goal orientation of urban activities: it represents a crystal formation whose growth direction is connected to, and constrained by, meaningful paths.

For comparison, one can consider other path-oriented designs that resemble linear crystals. A first category includes the development of pedestrian streets and precincts in city centres since the 1990s, following the trivialization of suburban shopping malls. While it may look like a return to pre-industrial city centres, the new pedestrian street is, in fact, a new way of transforming the shopping mall into a linear crystal to be incorporated into the traditional urban fabric. During the first decades of its life, the pedestrian street was often linear; only later was it developed, upon occasion, into ring-structured precincts (Kärholm, 2012, pp. 41f.; Monheim, 1975).

A second category includes the case of some flagship urban regeneration projects. For instance, the Spanish city of Valencia’s Plan Sur (1965–72) was conceived after the 1957 inner-city flood and the rerouting of the Turia River. Initially, according to a classical modernist template, a highway had been proposed, and it was only citizens’ mobilization that materialized Ricard Bofill’s 1982 master plan, with 450 acres allotted to greenery. The Turia Riverbed Park imparts a specific direction to the surroundings: suddenly – much like ice on a winter day – a former impediment (water, space not for walking) becomes a possible hub of pedestrian through-movement. Phase transitions can indeed alter the path potentials of a locale. The regeneration project came with a new concert hall in 1987; the development of the City of Arts and Science (with planetarium, aquarium and science museum), planned and designed by Santiago Calatrava on the former riverbed, followed in the early 1990s. Functioning as a new urban infrastructure, the former riverbed allowed a better connection between the city centre and the port, and became an important catalyst for further regenerations. The City of Arts and Science became not only a major tourist attraction but also the main ‘symbol of a new and modern Valencia’ (Prytherch & Maiques, 2009, p. 112). Once again, certain architectures can come to function as those ‘crown crystals’ first envisaged by Taut.

A more recent, and possibly even more iconic, crystallized urban path is the NY High-Line linear park (2009–19), reclaiming a former New York Central Railroad spur on the west side of Manhattan. Gandy (2013, p. 1306) describes the park as an ‘ecological simulacrum’, where the spontaneous vegetation of the abandoned tracks has been replanted into a park pattern. The park has changed the boundaries between public and private and accelerated real estate speculation. The High Line’s role of provisioning of green space for the neighbourhood already from the start became secondary, or even third, to the role of catering for new real estate developments and attracting tourists (Lang & Rothenberg, 2017; Millington, 2015).

Interestingly, both these cases of new linear parks illuminate how vegetation and crystallization work both jointly as well as against each other. The NY High-Line park was somehow initiated by weeds, while in Valencia it was a flooding that created the physical environment where the future park would be located. These considerations suggest that crystallization can be considered within a more general framework concerning the nature of various ‘urban states’, together with the transitions from one to another and the boundary interactions between them. More than separate domains independent from one other, vegetality, minerality and animality signal states that are co-created in a complex, interlocked way.

CRYSTALLIZING THE CITY

Just as a whole crystal can grow from a single crystal germ, which represents its inception point (see points 3 and 5 above), so cities can form around a pre-urban *nucleus*, such as a castle

or a church. But cities may also grow around a *morphological frame*, such as a topographical feature – a ridge, a river or a coast, or around patterns of roads and paths (Conzen, 2004, pp. 251–255). All these elements can function as initial germs for the taking over of an urban ensemble in formation. In his urban–morphological analysis, Kostof (1992) has insisted that the development of urban patterns is almost always a mix and puzzle of ‘premeditated’ and ‘spontaneous’ segments. This suggests it is better to avoid conflating crystallized urban forms with necessarily planned city parts.

Indeed, crystallization may as well emerge from spontaneous uses. For instance, in early medieval Rome, ‘tracks skirting or crossing the ruins of those public buildings [inherited from antiquity] for which there was no longer any use crystallized into new streets’ (Kostof, 1992, p. 48). This phenomenon bears similarities with what Paramita and Schneider (2018), after Richard Sennett, have discussed as *passage territories*, that is, ‘spaces that are both physically defined as well as mentally constructed by one’s experience of passage through and between [them]’ (p. 115). Because passage territories work as a collection of perceptually, figuratively, functionally and practically interconnected places, they enable the crystallization of a given space through recurrent use by either a single individual, certain social groups or a whole collectivity. While the process seems gradual, it in fact may lead quite quickly to the opening up of new paths and new spaces.

Interestingly, the idea of urban infrastructures as crystallizations and as forms of territorial stabilization can be found in several spatial theories of movement and form developed during the 1970s and 1980s, such as, for instance, space syntax and time geography. These theories seek to capture how built and unbuilt patterns constrain movement and establish lines of mobility through the urban tissue (see further our discussion of the ‘path scale’ below).

In time geography, Hägerstrand (1985) first stressed that the establishment of movement patterns has to do as much with time as with space: where you can go in a city must always be related to the time (and the speed) you have at your disposal. Hägerstrand speaks of ‘pockets of local order’ to describe a stable situation sustained by the fact of connecting and regulating certain resources within a particular time-space (Lenntorp, 2004, p. 225). A pocket of local order is, in other words, an infrastructure and a regulation system supporting the set of activities that has been designated for a certain territory. Pockets of local order can have a nested structure. For example, once we consider the home as one such pocket, activities within it can include further pockets capable of structuring enveloped time-spaces, concerning various hosted activities such as cooking, eating, sleeping, etc. (Ellegård & Vilhelmson, 2004). A pocket of local order thus acts as a kind of crystal that stabilizes paths and related courses of action within given time-spaces, or territories, affording for the legibility of spatial situations (see points 4 and 7 above).

Space syntax, as elaborated in particular in Hillier and Hanson’s *The Social Logic of Space* (1984) and Hillier’s *Space is the Machine* (1996), discusses how buildings and blocks in traditional European cities were ordered so as to maximize easy grid movement through the city. The historical development of cities sought to keep the longer and more well-connected streets that lead through the centre of the urban tissue uninterrupted, while affording calmer and shorter back streets in central positions. This strategy resulted in the so-called ‘deformed wheel structure’ (Hillier, 1996). Space syntax analysis suggests that both physical movement and the field of vision may become simultaneously more structured and more strained as the city expands (Hillier, 1996, ch. 9).

The structure of the most well-connected streets, sometimes known as the ‘integration core’, is for Hillier (1996, pp. 335ff.) one of the most important features of a city as such. This core, which can take on different shapes, provides a crystallized, stable urban structure that confers to each city a sense of core identity and uniqueness. The integration core differs dramatically between traditional European cities (of medieval origin), modernist cities, American grid cities

and Islamic cities, making the navigation across them a remarkably different experience. This is probably why Hillier in his analyses often tends to favour cities with crystallized cores, such as London, over cities with less crystallized movement patterns, such as, for instance, Brasília (Hillier, 1996, pp. 216ff.).

Once again, we are led back to the peculiar role of temporal, historical and relational dimensions in the work of crystallization, as well as to the emergence of a type of 'crystallized perception' (see point 7 above). Before moving to the conclusions, a more general consideration of the role of scale and equilibrium in processes of crystallization will be advanced.

METASTABILITY, SCALE AND TRANS-SCALAR CRYSTALS

In the previous sections we have briefly touched upon crystallization processes as they manifest themselves at different urban scales. As noted in the introduction, crystallization entails a phase transition unfolding in a special temporality, which also means that the accelerated pace that contradistinguishes crystallization – or, conversely, crystal dissolution – can appear at certain 'threshold moments'. *When* – one may ask now – are those moments? And, *How* to recognize them as they occur? In the case of Times Square, for instance, as reconstructed by Berman, a series of events during a short lapse around 1900 set in motion a crystallization that would stabilize this form of urban life – together with its associated materialities and medialities – for at least a century to follow.

The individuation of a certain crystal (see point 2 above) is co-created with a specific environment (see point 3 above) and develops a pattern of growth in relation to that same environment. This is observable when a crystallization process is in its infancy. After the establishment of the New York High-Line Park it was, for example, easy to see how the blocks adjacent to the park were affected by the change: the former backsides were now suddenly facing an important public space. A new privileged direction appeared to which the built environment was increasingly receptive: facing the High-Line Park (as opposed to turning its back to it) became the new imperative, as former backyards turned into exhibition spaces – for example, for the street-art installation *High-Line Zoo* in 2012. Unsurprisingly, the new buildings constructed afterwards were organized in ways that differed from the previous dominant orientation.

In more abstract terms, we could say that crystallization incepts from a condition of 'metastability' that allows for a certain rhythm to be established, and ensures a given formal outcome, or at least a possible range of outcomes. For Simondon (1958–89/2013), in particular, metastability is the necessary precondition for processes of physical individuation, and hence also for all crystallization as an individuating process. The crystal, in a way, can be said to propose a 'solution' to a situation of energetic metastability. A metastable situation is one 'rich in potentials', where many possible contradictory equilibrium points could be actualized: 'Everything unfolds as if the metastable equilibrium could not be broken but by the contribution of a singularity contained in a crystalline germ, capable to overcome the metastable equilibrium' (Simondon, 2013, p. 78; our translation).

Crystallization thus appears as a spatio-temporal dynamic of incipient ordering introduced within a metastable system. Such 'ordering' is what a general science of territories seeks to investigate (Brighenti & Kärrholm, 2020). Operating through rhythmic ordering, crystallization sets a new environment for different types of territorial stabilization, and for the ways in which these can co-act. So, Times Square is a place stabilized by way of bodies (billboards, crowds), networks (actors aligning in stable ways, such as the subway system, the electric network), associations to other sorts of spaces (Hollywood, Disneyland, The Broadway theatres, television – all spaces of spectacles) and frames (becoming increasingly dependent on 'absent friends', such as airports, restaurants, hotels, suburbs, tourists) (Kärrholm, 2012, pp. 57ff.).

In a crystallized state these different modes of stabilization may develop a certain level of co-dependence. Much like life itself, crystallization becomes auto-catalytic (see point 6 above) (Solé & Goodwin, 2000). The individuation of a place such as Times Square as a crystal means that we are operating on the basis of a metastable state out of which the parameters for different co-working stabilizations are set. The features of a physical individuation become those of a truly individual entity capable of prolonging the operation of individuation within itself. Times Square has surely changed over the years and yet, according to Berman, it has remained the same individual. People have at Times Square, as everywhere in debates around important urban places, tried to 'use nostalgia to suck the life out of the present' (Berman, 2009, p. 217) – but repeatedly failed: the place exhibits the robustness and self-centredness that is typical of a living individual.

Berman concludes (pp. 224ff.) that one of Times Square's quintessential functions – a function it has in common with other places of entertainment in urban history since Roman circuses – is that it allows you to become part of the city spectacle – perhaps, to participate in an embodied myth, or a living urban legend. The place has saturated its environment to the extent that not much else than this myth now seems possible. There is, for example, a tight relation between the fluidity of crowds, Broadway shows, advertisement campaigns (a stabilization of a spectacle site by way of territorial sort) and the material stability (stabilization by bodies) secured by the adjacent theatre buildings, the electric billboards and the square's very location at one of the most important crossroads of the Manhattan grid, as well as its subway system. This, in turn, is fed by continuously organized networks producing Broadway shows, commercial and public events, while also managing urban maintenance, public transport system, the tourist industry, etc. The high number and the different forms of co-working stabilizers suggest that it would take a lot of work to undo, break apart, 'melt' or 'corrode' the urban crystal of Times Square.

At the same time, it is important to recall that, for Simondon, a new individual does not simply overcome or destroy metastability, rather, it interiorizes it and uses it for its own purposes. In this sense, every individual reality continues to carry within itself a reservoir of the pre-individual system out of which it has emerged. From an urban perspective, the crystallization of different time-spaces sets different limits and rules that have to do with form-taking (or, morphogenetic) processes and the enabled speed of change – where the crystal phase, in general, offers more order and slows down some chaotic aspects of urban life. This way, crystals enhance the legibility and recognizability of an urban form: they are, so to speak, embodied recognizability (see point 7 above).

The production of urban scales is inherently affected by crystallization. Caniggia and Maffei (2001, p. 245) have suggested that scale 'describes a different level of complexity of the components internally arranged to construct a whole', implying that scale must be seen as a relationship between spaces of different dimensions. The elements of one urban scale become a mere 'component among components' (pp. 68ff.) at another: this means that one would need at least two different levels of complexities (e.g., those of 'a city' and 'a region') to produce a scalar relation.

In other words, nothing has a scale of *its own* – it only gets a scale once it is related to an entity of a different level of complexity, organization or extension. In this respect, a theory of urban crystallizations could be of interest not only to discussions on morphogenesis and territorial stabilization, but also hopefully in relation to the debate about geographical scales (Brenner, 2001; Latham & McCormack, 2010; Marston et al., 2005). In that debate, some scholars have argued that power is hierarchically structured and that scale is an important arena for political struggles of power (Brenner, 2001; Jessop et al., 2008), whereas others have replied that scale is in general not a good way to make sense of the world and its spatial transformations (Marston & Smith, 2001; Smith, 2010). Similarly, some have seen the power

of scale as the embodiment of a contemporary hierarchical, top-down political economy (Brenner, 2001), while others have insisted that scale can also be produced bottom up by spatially and temporally situated bodies in everyday life (Marston & Smith, 2001; Nielsen & Simonsen, 2003).

In that context, urban crystallization can be regarded as affecting the establishment of relevant scales of imagination and action, and the hierarchy of those scales. Intrinsic to crystallization is the precipitation of a certain scale as a 'natural' solution, often obscuring the empirical production process through attempted changes in consistence of an environment. As places such as Times Square, or The High-Line Park, or the Turia Riverbed Park crystallize, they establish a powerfully scalar form: a new crystal nucleus appears that other urban components and wholes will increasingly need to relate to. Crystallized spaces are qualitatively distinct: an asymmetry between them and other spaces sets in (see point 5 above), whereby crystallized spaces can be increasingly prolonged towards other contexts. In terms of scalar reasoning, one local whole may become a component of components in an increasing number of other situations: Times Square, for instance, sits among the landmarks of New York as well as among the touristified plazas of the world. The establishment of a relevant scale of perception, imagination and action thus makes it possible for a certain urban object to move from one map to another, whether mental or physical: for instance, the High-Line makes it onto both a street map of southern Manhattan and a tourist map of New York sites to visit, with qualitatively different significance in the two cases.

Returning to Christaller, Lösch and central place theory, we see that relevant scales can be signalled by different indices: for instance, by population density, or by how a system of different market sizes (cities, towns and villages) works. Different relevant scales of analysis are produced by circuits of practice. Even though central place theory has been much criticized, the idea of well-established hierarchies of scale still echoes in much contemporary theory, where relevant scales tend to be preset, for example, to urban, nation-state and world – or local, urban, regional and global levels.

A theory of crystallization shows that a multi-scalar attitude is of the essence to discuss the different contexts in which wholes become components of further wholes, and how these contexts are affected by phase transitions (whether in the direction of crystallization, or in the direction of crystal dissolution). This is not to say that we should dismantle scalar hierarchies and opt for a pure network logic – as advocated by Christopher Alexander already in the mid-1960s (in an architectural context; Alexander, 1966), and subsequently by Actor–Network Theory, and then by 'scale-less geography' (Marston et al., 2005). For us, the most important point is to acknowledge that centres, or rather crystals of different form, size and duration, can be established and dissolved in non-linear ways – and, as they do so, a production of immanently relevant scales and scalar relations occurs.

Crystallization is not simply multi-scalar, but, as hinted above, it can also be trans-scalar – in other words, it does not simply relate to various existing spatial scales, but it corresponds to the veritable *invention of a new dimension*. If we consider, for instance, the Colosseum in Rome, we notice how the building stood not simply for a local artefact, nor for only an urban attraction venue nor even for a symbol of imperial power: at some point, it condensed within itself the stability of the whole of Christendom – as made clear by the old Middle Ages saying, 'As long as the Coliseum [*sic*] stands, Rome shall stand; when the Coliseum falls Rome will fall; when Rome falls, the world will fall.'

CONCLUSIONS

In this paper we have reviewed the emergence of urban crystals as a perceptual and factual process in the development of cities, as well as a possible method for the analysis of territorial

stabilizations in urban – although potentially also other – spatial domains. We suggest that the notion of crystallization can be useful for an understanding of urban morphology and morphogenesis that involves both questions of form and territorial intensities. Crystallization, we remark, does not necessarily coincide with design – if ever, urban design could be appreciated as one attempt among others to crystallize a given space. Crystallization is a formative process taking part in various types of territorial stabilization. The question as to why the crystal grows into a specific, individual form, we believe, can be answered by a study of individual urban morphogenetic processes, where the domain of morphogenesis coincides with the encounter and intermingling of the domain of form and that of energetics. Put differently, every form appears as the dynamic capture of a range of forces with an ensuing tensional dynamic that crosses a territory, either keeping it together or breaking it apart.

In this continuous field of forces, discontinuities and lines of rupture emerge. A crystal can therefore be understood as an ‘attempted solution’ to a systemic situation characterized by structural metastability. The latter indicates that the system state *has past* hope for stable solutions. Once a stable, static equilibrium has been abandoned, however, it does not mean that all equilibrium is gone. Metastable situations present us with a *dynamic equilibrium* that is rich in potentials – that is, rich in a virtuality of outcomes. Such a ‘richness’ creates an oversaturated solution that is ready to crystallize. As soon a crystal germ forms in a metastable state, all conditions are met for a phase transition towards crystallization. Selection and orientation are thus intrinsic aspects of the crystal transition (see points 4 and 5 above).

As the crystal germ grows, a kind of self-propelling dynamics sets in, whereby an array of heterogeneous factors and items switch towards a newly integrated order. The formation of urban crystals occurs in a temporal horizon that differs from the usual one: it is at critical moments that things speed up. This provides an important indication for urban research: developing this method of inquiry, one would first of all want to circumscribe the historical and temporal coordinates where oversaturated conditions are produced. Next, one should be able to bring into focus the threshold moments acting as bifurcation points where a deep reorganization of the urban materials prompts newly emerging formations.

The visibility (perceptibility) and temporality (rhythmicality and individuality) of crystallization are, as we have elaborated, intertwined: precisely, they appear as intertwined in the ‘now-of-recognisability’ theorized by Benjamin. We can explain this fact with two remarks. First, the crystal grows, not in blind material, but in a medium that is the visible itself, so that a zone of indistinction between materials and images is where urban crystallization unfolds. Methodologically, then, this approach recommends an analysis of the visibility formations that contradistinguish critical urban moments, with the understanding that the crystal is necessarily ‘to be seen’ (although, clearly, it is not always seen, and not all actors have the same vision). Second, the zone of indistinction cannot be severed from the now-of-recognizability. This is a ‘felt’ present where history does not flow regularly, but presents itself as a crystal accomplishment, as a kind of contemplation (Brighenti, 2020). As noticed above, this approach leads to a rejection of both evolutionist models – avoiding the idea of developmental sequences – and of dualist schemes – eschewing the dichotomy between physical and perceptual registers, as well as between visible and articulable levels. Finally, as considered above, this is also where the notion of scale intervenes: the crystal is, in a way, a scale creator, endowed with the capacity to travel across various ‘maps’, whether mental or physical. Scalarly, as well as trans-scalarly, the urban crystal has the surprising capacity – still to be studied adequately – to assert new alignments, coalescing new connections and new meaning.

DISCLOSURE STATEMENT

No potential conflict of interest was reported by the authors.

NOTES

1. 'The historical index of the images not only says that they belong to a particular time; it says, above all, that they attain to legibility only at a particular time. And, indeed, this acceding 'to legibility' constitutes a specific critical point in the movement at their interior. Every present day is determined by the images that are synchronic with it: each 'now' is the now of a particular recognisability. In it, truth is charged to the bursting point with time' (Benjamin 1999, §N3, 1, pp. 462–463).
2. Among the many examples, one can point, for instance, to the Notre-Dame de Lorette illumination: 'But the great reminiscences, the historical shudder – these are a trumpery which he (the *flanêur*) leaves to tourists, who think thereby to gain access to the genius loci with a military password. Our friend may well keep silent. At the approach of his footsteps, the place has roused; speechlessly, mindlessly, its mere intimate nearness gives him hints and instructions. He stands before Notre Dame de Lorette, and his soles remember: here is the spot where in former times the *cheval de renfort* – the spare horse – was harnessed to the omnibus that climbed the Rue des Martyrs toward Montmartre. Often, he would have given all he knows about the domicile of Balzac or of Gavarni, about the site of a surprise attack or even of a barricade, to be able to catch the scent of a threshold or to recognize a paving stone by touch, like any watchdog' (Benjamin 1999, §M1, 1, p. 416).
3. For an elaboration of these seven points, see Brighenti (2020).
4. See Fang and Yu (2017) for a recent, broad literature review of urban agglomeration models.

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