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NEW WAYS OF CONDITIONING SPACE AND PLACE IN DYNAMIC AND TRANSFORMATIVE ENVIRONMENTS

Liaising between the worlds of matter and the virtual

Gert de Roo and Claudia Yamu

Abstract

Spatial planning is currently being confronted with unprecedented change, which is taking place at the interface between traditional environments and the rapidly evolving virtual world (Axford et al. 2007, Sidhy and Doyle 2016, De Waal 2013). This situation provokes one of the most serious questions for contemporary spatial planning: *How can we develop a frame of reference for planning action and planning intervention within a world of ongoing and discontinuous change*? Change under discussion here is partially digitally constructed and virtually produced, affecting and transforming traditional space and place. No one knows precisely what the developments that emerge from this hybrid space between the material and virtual worlds will precipitate. Moreover, it is difficult to say what effects will materialize, not to mention the consequences of these developments: the current virtual world is already stunning and full of promise. New imaginary spaces are opening up (Sherman and Craig 2002), such as augmented realities, virtual realities, gamified environments and 'sensored' places within which digital access has replaced traditional mechanisms and means of interaction.

These rapid developments have consequences which are little understood and therefore need our consideration. Generally, at present, space is transformed into a place that is available for human use, with unique meanings and a specific kind of identity. And it is usually conditioned by institutional properties (LeGates and Stout 2007, Platt 2014). However, hybrid space is different from this usual space of development with enabling and constraining conditions, and to which we respond while also

complying with conditions that are democratically set by society. Within hybrid space, a new reality is quickly evolving and is having a tremendous impact on our lives and on society as a whole. We see this happening and find ourselves intertwined in this process, allowing these developments to set the terms, which contrasts with an environment with societally accepted conditions.

Digitally constructed and virtually produced spaces might become places within which contemporary conventions evaporate, being replaced by new conventions which are little understood or discussed, or even evaluated in terms of their societal appreciation. The question of how to consider the conditioning of hybrid space between the material and the virtual brings a more abstract issue into focus: *How should we consider the conditioning of space and place* anyway? It would be a timely quest to contrast planning's traditional focus on the material world with unprecedented developments within the virtual world, and the effects currently 'materializing' in our environment.

The virtual versus traditional environments

What is the 'virtual'? It is information made active, it is digital (instantly and on the spot), produced by algorithms and it assumes a sense of space and place, a sense of 'whereness'. The virtual generates information in such a way that our brain can 'understand' it as a construct connected to and positioned within space and time – a fluid connection between our neurological network, virtual information and the world of matter.

It is difficult to define virtual space in terms of place, place-making (Sherman and Craig 2002) and place identity (Bassett 2013), or as space that can be made our own and to which we can connect and relate as a dimension of our daily living environment (Qvortrup et al. 2002). Moreover, it is even more difficult to understand how the virtual relates to rules and legislation, and to social conventions about how to interact with others. While we are used to these conventions within the world of matter, what about conventions within the virtual?

For urban planners and designers, the material-virtual interface refers to spaces which are, on the one hand, geographically located, physically constructed and somehow connected to the public domain and, on the other hand, are connected with, informed by or built out of digital data, circulating in social networks, computer games or mobile phone networks. Thus, we are confronted with the question of how to condition space and place at the material-virtual interface, with new 'rules of behaviour' telling us how to act and interact with each other. Consequently, these spatial conditions and how we interact in space (material, virtual or the hybrid space in between) are identity-shaping and should concern us, especially who we are and who we want to be. This is also relevant to the virtual

world (Jacobson 1994, Sherman and Craig 2002, Wells, Rudnick and Miyoshi 1992).

Threats and fears

We can argue that the virtual is an imaginary place which is becoming an increasingly real part of our social existence, wellbeing and identity. However, there is another, more negative side to this, as it also has non-social or asocial effects. Indeed, in public space we can observe people who do nothing but stare at their screens, obviously unaware of their physical environment.

This is just one of the various reasons why the virtual, considered as an imaginary place in which we exist, act and socialize, forces us to redefine the notion of 'public' (Camp and Chien 2000). Another reason to redefine 'public' is because the virtual is an information-generating environment which is rapidly evolving towards a profile-generating algorithm. This algorithm makes use of all the information about us in the 'cloud'.

One possible next step would be to be able to connect – through a face-recognition algorithm – with any other person in public space, on the basis of being provided with real-time information about the other person presented by an augmented device which allows us to interact instantaneously – when all the bells start ringing because of the perfect match with the other person we are just about to encounter (Gladwell 2005). How will this change socio-spatial behaviour? No doubt a new kind of socialization will emerge.

Social clustering, social exclusion, inequality and filter bubbles are just a few of the notions that are being presented to us, accompanied by warnings that virtual technology can lead to coldness and moral indifference, with digital observation replacing direct interaction and meaningful dialogue. One example of this is collectives interacting through social media on the basis of what participants share in common, and not being challenged by counter-arguments and opposing views (Pariser 2011).

In addition to potential segregation, another divide will emerge: that between the active and lazy users of the internet and social media, those who 'lean in' versus those who 'lean back'. The former might make use of the 'principle of collaborative filtering' (Herlocker et al. 2004), and profit, for example, from the 'Discover Weekly' algorithm (Cowan 2017), broadly seen as the first well-functioning algorithm to understand taste (suggesting songs by establishing levels of appreciation).

Another warning that is heard concerns Airbnb, Instagram and other trend-setting virtual social constructs which appear to be resulting in cafes, hotels and bedrooms that are seemingly the same everywhere on the planet (Arvastson and Butler 2006). Planners have seen this before, in the 1960s, with egalitarian concrete constructions everywhere (Jencks 1977), supposed to be appreciated by society, which did not actually work that well, resulting in these constructions now being abandoned.

Possibilities and opportunities

Change comes with concerns and fears, a 'natural' defence mechanism to resist undesirable effects. However, in general, the interactions between the material and the virtual worlds have evolved along various routes of development, generating an almost endless range of possibilities and opportunities. Just to mention a few:

Being present elsewhere in the material world via the virtual: not the here and now, but the now and there. Teleworking and online shopping, for example, not only change daily routines and how we use spaces but also influence urban planning with respect to location theory (von Thünen 1826, Dicken 1990) and land use. Distance is no longer a physical barrier that needs to be overcome.

Being present elsewhere in the virtual with reference to the real: with 3D virtual reality headsets such as Oculus Rift and Gear VR or Google Glass. The possibilities range from existing opportunities to walk with dinosaurs or to do surgery with robots, to allowing us to walk through newly designed space and analyse it. It is fascinating, despite its visual bias.

Being guided in the physical world by the virtual: Global Positioning System navigators now allow easy navigation through unknown territory (a dynamic city for example) and can make suggestions about how/where to move. This could be important for sustainable traffic management and congestion mitigation to avoid traffic jams and/or endlessly patrolling through town to find a parking space. With the increasing precision in location and in time, car-sharing, self-driving cars and their actions are just a minor step away.

Being present in the here but through simulation going forward or backwards in time. In virtual reality (VR) environments (Sherman and Craig 2002) and through decision-support models and simulations (Geertman et al. 2015), urban planning and design issues can be shared with stakeholders in various ways. Interactive responses allow the generation of a better understanding of how, for example, future spatial development can result in feasible and appreciated solutions.

Being in virtual space and the specific rules that come with it: in other words, gaming. Apart from fun games, the field of serious gaming is emerging (Kapp 2012), quickly becoming a significant development for planning and decision-making. While gaming against the backdrop of an actual spatial situation, gamers are confronted with the various aspects, perspectives, options and solutions to the situation at hand and become aware of others in the game, their attitudes, desires, needs and willingness to commit and contribute to improving the situation.

Being informed by the virtual within the material: augmented reality. This development is known and appreciated for presenting information concerning material objects. It is likely it will further develop to address and replace various symbols now physically positioned in space, such as traffic

signs and advertisements. Rooms in the material world with no more than the basic essentials might also be virtually decorated according to individual taste, with the user bringing in virtually symbolic and cultural values, generated autonomously in compliance with the user's personal profile through information from the cloud.

Reciprocal awareness of the virtual and the material environments adapting to us: here we are thinking of smart environments with personalized response sensors, which not only sense but are nodes in virtual webs, and therefore open to information already generated by us, stored somewhere in the cloud and assessed by algorithms to inform these nodes, in turn, about how to respond to us, our environment and the various devices within that environment.

The city as user interface (1) – social media (De Waal 2013): this concerns activity awareness and spatial events. One of the unprecedented effects of social media is the coming together of many willing to give expression to a cultural or political standpoint within the material world and, as such, ensuring the 'world' is taking notice (e.g. a 'flashmob').

The city as user interface (2) – dynamic living lab (De Waal 2013): here we are thinking of the relationship between the local and the global, between the individual and the collective and between the situational and the generic. The city is a dynamic living lab, supporting mobility and liveability in a 'smart' way, with sensing and operational devices everywhere. Here, we have 'the magic of software that will connect these devices into a seamless whole, making them an indispensable part of our everyday lives' (Gates 2000).

Digitally constructed virtual spaces mirror material spaces and their structures and functionalities. It is these structures and functionalities we respond to. They influence our actions and the sequence of actions, such as when we move from A to B. The virtual relates somehow to similar laws and conventions, as long as it serves users to consume and/or reproduce the information presented to them. The virtual is understood as long as it resonates well with our cognitive brain, while the digital environment's logic, with its models and simulations, is produced by algorithms which are usually not identifiable by or visible to the user, abolishing the laws of physics and social conventions. The virtual thus allows us to move, take shortcuts and make leaps which do not work in material space: 'mirror worlds', in the eyes of Gelernter (1992).

The route from one digital environment to another does not relate to spatial constraints. Connectivity is multidimensional within the virtual, which is the essence of digital space. Moreover, as virtual spaces are plentiful, it is the logic of possible connections that lead us through the virtual, allowing us to flow from one cluster of information to another, from one digital environment to another. This works well as long as our brain is able to understand and process what is being presented from within the virtual. This requires an understandable logic and conditions that are appreciated,

as well as some representation of causality; a successive order of events and behavioural conventions. 'We are moving towards a culture of simulation, in which people are increasingly comfortable with substituting representations of reality for the real' (Turkle 1995, p. 23). Within the virtual anything is possible, with the conditioning factor being us: humans.

Trajectories of development

The differences between the material and the virtual are substantial. Nevertheless, the material and the virtual worlds do relate to each other in various ways. One way that we consider relevant in our quest for 'conditions of space and place' is their paths of development. We could easily argue that the idea of the virtual is a product of the world of matter. While this is valid reasoning, it does not help us much in identifying the origin of the new set of rules emerging with the virtual. The virtual has its own set of rules that somehow relate to us as humans, but which condition us in a way that is different from what we are used to. Therefore, despite their relations it is worthwhile to consider the material and the virtual having both their own trajectories of development.

The world of matter

The trajectories of the material and the virtual worlds produce fundamentally different conditions to which humans must relate. The material world builds on particles that conglomerate as material entities. The virtual relates strongly to waves of electromagnetic oscillations of packages of energy. In physics, both views – particles and waves – are required for an understanding of elementary processes. Since Einstein we have considered that matter and energy are equivalent in some sense: matter and energy are two sides of the same coin. However, although they are interconnected, matter and energy present themselves differently to us and are of use in different ways.

The material world presents us with a trajectory from which life forms emerge. In its relative slowness, matter is able to cluster, interact and produce amino acids if the conditions are right. Amino acids are the building blocks of life, combining into strings of DNA, genetic codes and reproducible information (Capra and Luisi 2014). Life forms not only duplicate themselves, but they respond to and interact with their environment.

Within the world of matter, we see a trajectory that is sequential. The social cannot do without biological conditions, and biological conditions cannot survive without the physical being present. The physical is a robust layer that allows biological phenomena to flourish. Moreover, both the physical and the biological are robust layers that allow a social world to develop. The various layers produce their specific rules and conventions, which condition us and our environment. In other words, these rules and conventions condition space

and place. Partially, this is about conditions being existential (*Existential conditions*: Table 1.1), and partially it is about conditions to which we relate our actions and behaviour (*Behavioural conditions*: Table 1.1).

The difference between the two is subtle but relevant. The existential conditions represent the robust layer of our existence: the conditions we cannot do without. The behavioural conditions form a dynamic layer which allows us to accommodate ourselves to our liking and progress within our own anthroposphere. With the rise of humankind, a species came into being with the intention and the capacity to rearrange, transform and develop its environment completely, moulding flora and fauna for its own use, and constructing all kinds of artefacts, with cities perhaps being its most astonishing accomplishment.

Humans might have emerged from within the world of matter, but they also make use of energy as well: from appreciating sunshine and controlling fire to constructing energy networks which power a huge range of instruments, tools and machines, including the computing devices generating the virtual. At some point in the future, possibly not far from now, one might reconsider the creation of cities as no more than a consequence of a kind of behaviour humans were used to from the moment they decided clothing was not enough, acknowledging that convenient shelter is desirable as well. In retrospect, the 'discovery' of electricity in the nineteenth century and the possibility of using it in so many ways might be considered more relevant and crucial.

The world of energy

We are just beginning to imagine what this might lead to. Our use of energy changed once we learned how to generate and store electricity (containing) and use it efficiently (through batteries and insulated copper wires), with the possibility of controlling the flow of energy (carrying). The flow of electricity progressed in the second half of the twentieth century towards a kind of electromagnetic mechanics known as electronics. The invention by Lilienfeld in 1925 of the transistor, a semiconductor, brought the possibility of automated choice within reach: 'what if' options, yes or no positions, as well as the digits '0' and '1' (coding). This shifted focus from flows of energy producing heat and power, to electronics and the possibility of information being generated, carried, contained and processed, more or less instantly (at light speed). The transistor, as the building block for the calculator, proved to be just one step away from programmable computers (Timsit and Zertal 2013).

Computers do not just compute but can execute orders based on a set of instructions we ask the computer to follow. This set of instructions is now known as a 'software' programme, designed for specific tasks, to be replaced by other programmes when different tasks are required. In the early days, computers (e.g. Z2 by Konrad Zuse 1939, TRADIC by Jean Howard Felker

1954 at Bell Labs, Mailüfterl by Heinz Zemanek 1956–1958 at TU Vienna, or TX-0 1956–1960s by MIT Lincoln Laboratory) were, above all, 'operating systems' allowing the user to do predefined tasks. Software can be understood as a predefined task, encompassing a means of communication between it, the computer and the user. With the advent of the microchip, this all became accessible to individuals in the 1980s.

Despite the flexibility of software, these early programmes were still very much static products for tasks such as word processing, spreadsheet calculations and data storage. A fundamental evolutionary step occurred when individual computers became connected to each other: the World Wide Web (Tim Berners-Lee in 1989) of information-sharing was born. As information became digitally available, search engines such as Altavista, Yahoo and Google introduced machine-learning algorithms which became the very heart of globally operating software, selecting and combining particular information in response to the user's requests and preferences, wherever the user was, instantly – both the information and the users having digital addresses within the virtual: *the virtual was nothing but traceable information, users included, readymade to be processed by algorithms* (Sherman and Craig 2002). The condition of being physically located somewhere within the material thus evaporated. The information age had arrived, triggering a whole new range of developments.

It was the combination of computing power, of global, local and open access to information, and of 'smart' algorithms, which made it possible to do far more than execute specifically defined tasks. Algorithms anticipate tasks by combining, synthesizing and aggregating a variety of signals, including circumstantial ones. The algorithms sense how individuals, groups and population categories behave and act, and what they feel, need and appreciate. This information is to be made useful for their benefit. Most of us are aware of its economic power and the system's algorithm attempting to influence purchasing behaviour. Basically, any kind of behaviour can be influenced by algorithms for reasons no longer clear to those connected.

The internet of information also developed into a global platform for social networking, also known as 'social media' (Albarran 2013). It is no longer about tasks we want algorithms to do, but instead we generate individual and personal data being the prime target for algorithms and the virtual network to work with. A diversity of global communities grouping around various means of information-sharing – Facebook, Instagram, Twitter, Snapchat – are all generating and sharing personal information as input for algorithms. All kinds of devices that are connected and able to process information can feed the 'cloud', which provides the necessary memory, and ensures that individual information is stored and accessible everywhere and anywhere. Devices being connected also results in 'the internet of things', allowing users to communicate with their fridge, heating and lighting systems ('smart buildings'), and with their car and more ('smart city').

The robotification of our daily life is also progressing, with all kinds of machinery, tools and equipment communicating with each other, activated the moment it is convenient to us, or the moment the device, the cloud or whatever mechanism within the virtual world determines it is convenient to us. Again, this generates information about our actions, our needs and desires, which is input for algorithms from which new information can be aggregated.

The sensing and informing web is everywhere, from computer to smartphone, in fridges and microwaves, on our bikes and at work, making contact with personal devices everywhere through sensors positioned wherever possible. Through these devices, almost everyone and every product, tool and instrument is connected to the global network almost constantly, which makes it possible for the network to be interwoven and to have a reciprocal relationship with our devices and our lives: sensors are seamlessly embedded, and ubiquitous, pervasive computing is something we now have to live with.

Pink (in Howes and Pink 2010) labels this as sensory anthropology. This is a synthesis within which the world of energy and matter are entangled to the extent that information obtained from the world of matter is aggregated within the world of energy, with the world of matter resonating with whatever information is produced. It is an endless loop of information-generating and information-sharing activities in the making. Through algorithms, the virtual sensing and selecting of information is based on personal characteristics aggregated from our interactions with the web, and with others via the web, interactions about which we are increasingly unconscious (Katz and Rice 2002). These interactions allow algorithms to generate new information, which is stored, combined, transformed and reproduced to reach a level of knowledge which makes us aware the 'system' is often better informed than we are, including information about ourselves.

It is quite difficult to gain distance from this information-generating network, as the system rewards those participating, with consequences arising from mass interaction, and those not participating being excluded. The network is aware of every action, move and choice the individual user makes under each specific circumstance (Vakali, Angelis and Giatsoglou 2013). The network is about to turn things around, no longer being asked to deliver a task, but proactively taking action, as it 'knows' beforehand what we want it to do or deliver. Even now, the system is already better than we ourselves in recognizing who might be a wonderful partner to share our life with. The downside might be that the individual, being subject to observation, finds its behaviour subject to evaluation (Morozov 2011). To the system, all we are is information.

As is the case in the material world, we must acknowledge each level of development within the virtual to be the consequence of lower levels of existence. In other words, here too various levels or stages build up sequentially and, to some extent, the higher levels of existence will not be

Table 1.1 Conditions matrix for hybrid space between the material and the virtual

	World of matter	*World of energy*
Dynamic and culturally, socially and economically produced	*Behavioural conditions* Between governance and self-organization	*Performance conditions* Intentional: passive, active and self-producing information
Robust and essential, to which we conform	*Existential conditions* A given; although open to interventions	*Instrumental conditions* Intentional, based on technical discoveries

able to perform and function without conditions produced at lower levels. Instead of the physical, biological and social, the levels of existence in the world of energy can be labelled 'containing', 'carrying' and 'coding'. These layers are essential to performance and functionality. Here too, these levels condition the world of energy in two ways. The robust layer is instrumental (*Instrumental conditions*: Table 1.1), emphasizing the hardware, the software and their operational modes. The other is performance, in particular, the way the digisphere is exposed or presented to us (*Performance conditions*: Table 1.1).

A changing space-time perspective

The interdependent worlds of matter and energy are transformed in such a way that our space-time perspective changes rapidly, with major impacts on the way we behave and act and the way we see and perceive our environment. The period which first stands out is the Industrial Revolution, a period within which matter and energy collided, steered by the desire for mass production. It also meant the use of tools for the sake of production: tools and production with power and speed far beyond a human being's physical capabilities (Trinder 2000).

During the age of industrialization these 'tools of power' were not only a means of doing something, but also became adapted as modes of transport and mobility, such as the steam-engine, motorcycles, cars, aeroplanes and rockets. Contained and controllable power meant objects could be turned into motion. Consequently, the infrastructure changed, with the need for a road network allowing for high-speed transportation. Moreover, this also meant a tremendous increase in the use of energy resources. It transformed the metabolism of cities (Kennedy et al. 2011). Due to the ability to move around faster and further, the time-space continuum shrank rapidly, centring on cities, inner cities, intra-city movement, with the local interacting with the global: the emergence of the 'global village' (associated with McLuhan 1962).

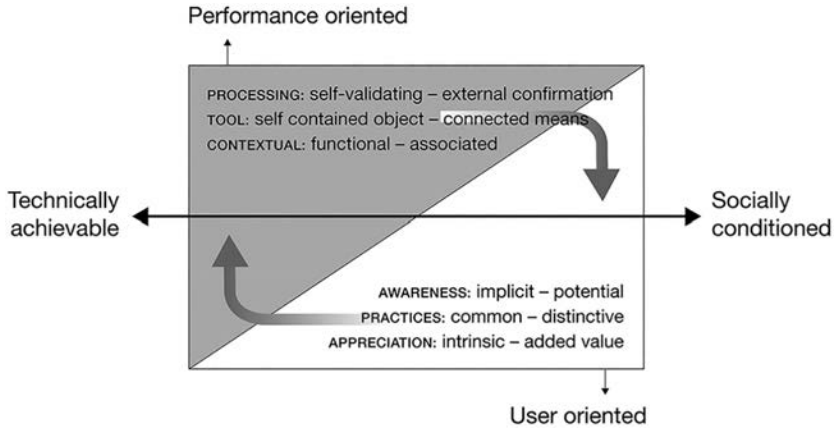

Figure 1.1 Cognitive model framing socio-technical development, its contingent relationships and circular trajectories (after De Roo, 2015, 2016a)

Figure 1.1 frames and explains an evolutionary trajectory of socio-technical developments, including the process of industrialization, the era of communication and the rise of the information age. It is produced on the basis of a generic cognitive model emphasizing a differentiated worldview: on the left-hand side of the model (grey triangle), objects, entities or situations predominate (here called 'tools'), as well as the way they are processed and their contextual linkages. If the meaning of what is observed is not explicitly clear and distinctive, a move to the right becomes necessary, adding intersubjective and explicit meanings about what is being observed (the white triangle). In other words, both fact and value matter for every object, entity or situation observed and positioned somewhere on the spectrum between 'technically achievable' and 'socially conditioned'. If the circumstances are such that uncertainty reigns, the intersubjective orientation on the right (white triangle) will predominate, including its prominent perspective (here called 'awareness'), possible consensus about joint practices (behaviour) and the leading discourse about what is observed (appreciation).

In other words, in situations which are certain, 'factual reality' is the leading orientation of the cognitive model. In situations which are uncertain, the cognitive model produces an 'agreed reality' as the answer to coping with reality. Additionally, and depending on the degree of certainty regarding observations and reality, the model presents a ratio between performance and user orientation (or more generally: object versus intersubjective orientation).

The cognitive model does more. It also gives expression to circular routes of development between certain and uncertain understandings of reality, which we can illustrate by looking at the era of communication (Gleick 2011). This period provides another example of how the world of energy has had an impact on the world of matter, transforming our time-space

perspective even further. The communication era has seen incredible change, with the telephone being a spin-off from the entanglement of the world of matter and energy. In the early days, a telephone was a self-contained device located in the hallway of people's homes. It self-validated its function: it was a means to be heard at a far distance (at light speed). And it worked! To get through, one had to be connected by an operator, and had to be lucky enough to find someone available at the other end. The moment connections could be made without an operator, by dialling a number (representing a person, family or office), society began to confirm and to validate the potential of the telephone even more. The device was upgraded to the living room, put on a table next to dad's chair.

The possibility of storing the connecting numbers of various family and friends represented the beginning of a network. With the telephone, society developed as well, increasingly considering it a right to be connected: this led to the external confirmation of the phone as being of intrinsic value by becoming part of a communications network.

The mobile phone introduced an entirely new functionality. It meant an end to the necessity of being near a fixed phone line. Everyone was suddenly reachable all the time, no matter when and where. The beginning of a new cycle of development and innovation began.

This was only a minor revolution compared to the generation of smartphones. It is even debatable whether the smartphone should be considered a phone at all, as the telephone function is but one of a million functions the smartphone is able to perform on the basis of produced, reproduced and contained information. One of those potential functions is the self-organizing structure of app production, through which the possible uses of the device keep on increasing. Another is it being a sensing device, connected to the internet, always and everywhere, ensuring we, and the data we generate, are also located in place and time.

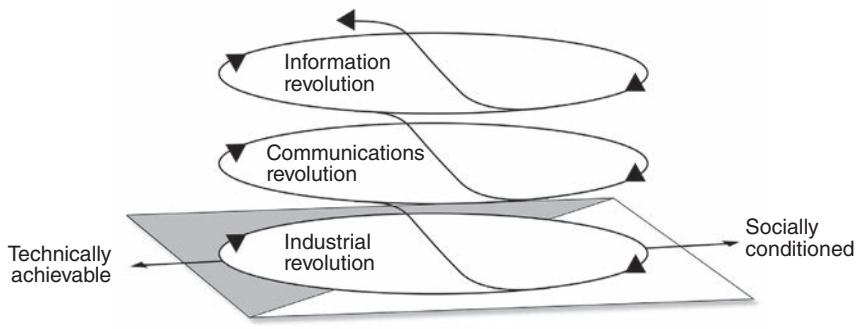

Figure 1.2 Transformations, framed by the cognitive model in Figure 1.1, being a sequence of 'evolutions' and 'revolutions' of socio-technical innovation (after De Roo 2015, 2016a)

The Industrial Revolution not only triggered mass production but also mass mobility, while the communication era triggered not only interactive networks but also mass information. The information age (computer age or digital age) builds on this information, which is no longer 'analogue' but 'digital', a revolution in its own right. It also triggered the 'virtual' as a coding power (a sequence of 0 and 1) and a new means for generating information. Codes are the building blocks of algorithms which not only instantaneously produce the information we demand (or do not demand), but also seek connections between various strands of information, which results in information being actively produced, reproduced and aggregated into new connections producing and reproducing information, and so on.

This trajectory of the industrial, communication and information revolutions has shrunk the space-time continuum and thereby 'reduced' the geographical world, while at the same time the virtual world of interaction, information and knowledge-sharing has expanded. In the virtual, the geographical world is non-existent, with information having an address only to allow it to connect with algorithms. Spatial expressions and the acknowledgement of time and place by the virtual is merely a by-product (Sherman and Craig 2002), although for us as humans it is substantially more than a by-product.

Information-sharing and availability are also barely constrained by space and time anymore, which brings the material world to us at a close distance from our centre of awareness and consciousness. No doubt, bypassing the senses to connect the virtual to the brain itself is another innovation of pervasive computing. And why not? Our brain is a nervous system and a network of electric impulses, not that different from the global web and its digital world (Jesan and Lauro 2003). It is a possibility within reach. At present, we are still very much part of a material environment that surrounds us, with the virtual intervening and turning the material into a sensing, aware environment.

Conditioning space at the edge of the material and the virtual: towards an institutional design

The cognitive model in Figure 1.1 frames the transformations expressed in Figure 1.2 as a sequence of 'evolutions' and 'revolutions' of socio-technical innovations. The cognitive model explains and frames what we observe and what we make of it. The interpretation given to the model in Figure 1.1 can also be seen or can function as a representation of conditions under which socio-technical innovations take place or develop further. In other words, we have returned to the issue of conditioning.

Here we are concerned with the conditioning of socio-technical innovations which consequently follow a circular route of development (see Figures 1.2 and 1.3). However, this circular route does not end at the point

where it started. Somewhere in the circle of development something has happened. Whether a leap, a bifurcation or a co-evolution, which brings the innovation to a higher level of development (theoretically also possibly a lower level), a transformation has taken place (Figure 1.3). This transformation will be likely to entail a co-evolution, with structure and function both having gone through a process of fundamental change, adapting and self-organizing along the way (Garnsey and McGlade 2006, De Roo 2016b, Portugali 2000, 2011, 2012).

The science of complexity tells us how to see such a transformation (Kauffman 1991, Keller 2009): it becomes manifest in what is called a 'complex adaptive system' (Nicolis and Prigogine 1977, Cilliers 1998, Miller and Page 2007). Unlike traditional closed, feedback and network systems, a complex adaptive system is never stable, always progressing towards equilibrium, but never reaching such a point. Instead, it adapts to disturbances in the context, internally self-organizing to obtain a better balance between an internal fit and the fit with the surrounding environment. We will focus in particular on the *conditions* under which a phenomenon, event or situation within this hybrid space adapts and self-organizes as a compact adaptive system.

The conditions under which a compact system adapts and self-organizes allow the system to transform in terms of content and process while the conditions remain the same (De Roo 2016a). In other words, a system transforms functionally and structurally while adapting and self-organizing, with the conditions under which it is transformed being the only constant factor. Over time, a system might be transformed several times and this may result in it being far from what it once was – as we saw with the telephone's transformation. However, the set of conditions remain the only point of reference connecting the system through the various moments of transformation. In other words, the conditions of system transformation are what give the system its persistent identity.

Figure 1.3 illustrates the transition, the route the complex adaptive system takes as it co-evolves. The complexity sciences tell us that a complex adaptive system consists of two layers, *a robust and a dynamic layer* (Miller and Page 2007). This allows the system to adapt dynamically while the robust layer ensures it is sustained. While this system thus has two internal layers, as a whole it is balanced on 'the edge of order and chaos' (Waldrop 1992). A city can be seen as such a system (Batty 2005, 2013). Cities rarely disappear, but they do undergo structural and functional transformations every so often, in a world that is shifting between stable and orderly, and unstable, chaotic periods. We assume hybrid space between the material and virtual can be seen as 'the edge of order and chaos', which functions according to the same principles.

The complex adaptive system explains how unstable properties do not disappear but maintain an identity on the edge of order and chaos, while

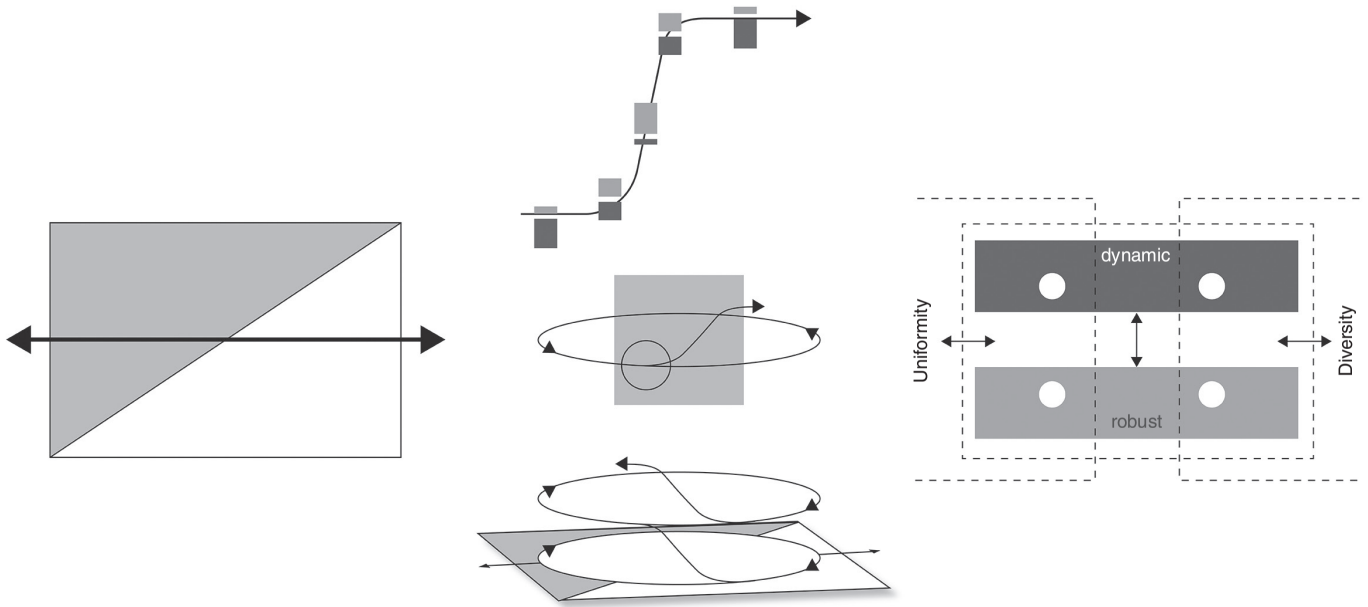

Figure 1.3 From a cognitive model framing development (Figure 1.1) to a complex adaptive system being a manifestation of such a development, with its four 'connectors' (○) representing each transformative condition (De Roo, 2015, 2016a)

being in a state of discontinuous change. No one will argue that the virtual world is not a highly dynamic environment, driven by change, infinite possibilities and imagination. In Figure 1.4 it is assumed that the virtual world represents diversity (chaos), while the world of matter represents uniformity (order). This makes sense as there is only one material world, while within the virtual, the worlds produced may be endlessly variable and diverse. A complex adaptive system will adapt to the external conditions (between uniformity and diversity), while internally self-organizing (robust-dynamic interdependence) to allow the complex adaptive system to seek a sustainable presence and a good/better fit with its unstable environment.

Figure 1.4 represents the hybrid world in which a complex adaptive system can exist, with the four conditions which we presented in Table 1.1. These are considered relevant within the hybrid world, giving the system its identity, while resonating with each other to seek a balance that works: *essential, behavioural, instrumental and performance*. The essential and the instrumental conditions represent the robustness of the interdependence. Moreover, the behavioural and performance conditions exhibit a more dynamic role in this interdependent relationship. This assists us to understand the conditioning of hybrid space – the user interface between the material and the virtual in which they collide, are transformed, adapt to, confront and surprise us: an eruption of revolutions with major impacts on our lives.

The positioning of the four conditions within this complex adaptive system is not random. *Existential conditions* above all represent the rather

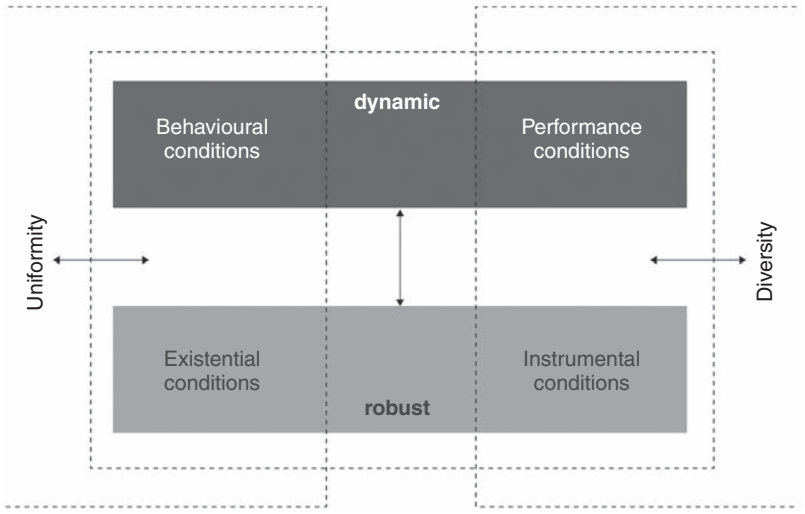

Figure 1.4 The complex adaptive system conditioned within in hybrid space between uniformity (the material) and diversity (the virtual worlds) (after De Roo, 2015)

persistent and robust rules, instructions and conventions which are a consequence of the physical, biological and social. They are the framing conditions under which humans live, act, behave and develop. Existential conditions are the stepping stones that humans use to explore the possibilities offered by the world that surrounds them, enabling them to relate to these possibilities and, if valued, to adjust their behaviour in such a way that these possibilities can be incorporated into their way of life.

Instrumental conditions above all (but not solely) are those required for the virtual to exist and to perform. They are the basis of (energy) containing, carrying and coding capabilities. While instrumental conditions allow for diverse production, this production is currently connected to a global industry with just a handful of main players. Some of these players are designers – in particular, from Silicon Valley – believing democracy is outdated, as they think technology – their technology – will deliver the truth, that is, a digital utopia in the making meant to support society. Instrumental conditions are expressions of robustness of the system (in Figure 1.4): The diversity which these instrumental conditions promote is such that if one of the available technologies or tools disappears or becomes obsolete the virtual will endure.

Performance conditions are crucial to ensure the virtual is a production space for meaningful developments and events. These meaningful developments and events are no longer constrained by the rules of the material world, such as the logic of consecutive order. Instead the algorithm is the conditioning factor; executed at the speed of light. This does not mean that causality and other 'essential' and 'behavioural' conditions are left out of the game. Everything that is produced within the virtual world or by a digital device must relate to these conditions in some way. While we generally think in terms of cause and effect, virtual realms have the potential to extensively redefine existing realities and relationships (Newton and Pak 2015, p. 112). It no longer matters how these realms are produced, as long as the product is perceived as 'real' or 'realistic'.

The logic of instructions

In the above we defined the conditions under which socio-spatial innovations can take place. Moreover, we defined the conditions for one socio-spatial innovation in particular: the hybrid space between the material and the virtual. Several critical questions arise here: Are we right to assume that hybrid space conditions a complex adaptive system? Are we right to assume that the material world represents stability and order and the virtual represents diversity and chaos, combining to produce interdependent conditions required for hybrid space to develop and be transformed? Finally, even if our assumptions are correct, the question of how these conditions work still remains.

Conditions enable and constrain the environment and our actions and behaviour. While the conditions under which our actions and behaviour take place in the material world are reasonably well understood, the conditions relevant to the virtual are far more dynamic, which leads us to ask: *What conditions ensure sensible action and behaviour in the virtual world*? The virtual world has a strong influence on us, leading us to new forms of behaviour and confronting us with the consequences, which can be unsettling. Our behaviour relates strongly to the various modes of engagement, from scrolling through information to choosing between options and virtual environments, from information-seeking and meaningful information generation to responding to displays, menus and a world full of new expectations.

While engaging in this behaviour, we also become a source of information production. However, we are often unaware of what we produce, who is interested in it and what 'they' are going to do with it. Safety and privacy are thus becoming major issues, as each and every one of us is overly connected. Other consequences are also becoming issues, such as the virtual world putting political discussions on freedom and equality under pressure (Morozov 2011). These are issues that we may not be able to resolve once and for all, due to the dynamic and fragmented nature of the virtual, and the different conditions and dependent forms of our connectivity to it. Nevertheless, privacy is taking on a different meaning while, according to some, it is evaporating (Morozov 2011).

There is definitely a logic of instructions to which all virtual environments relate and which agrees with the performance conditions presented in Figures 1.4 and 1.5. Such a sequence of instructions consists of algorithms which are meant to produce something meaningful. The design of these instructions is still more or less up to us, although in current developments we can see instructions interacting with meta-instructions instead of humans to enhance the system, the output or the interactions. What is emerging is more than 'a digital nervous system … that consists of digital processes enabling us to observe our environment and to respond to it …' (Gates 1999). Developments show algorithms being programmed in such a way that they produce new algorithms independently of a human programmer. Within the virtual instructions, rules and conventions are changed through self-learning and self-organizing processes (artificial intelligence [AI] and deep reinforcement learning). We can only assume that these digital instructions remain human-oriented (Bostrom 2014).

Would it be advisable that newly and autonomously created algorithms should be accompanied by information about how far-reaching their impact might be, and how they condition our environment? While this might sound reasonable, one wonders about its feasibility. Google's DeepMind project (taken over by Google in 2014) is in this respect an eye opener, with the creation of a neural network that learns how to play video games in a similar

fashion to humans (reinforcement learning). While stating that '[o]nce artificial intelligence reaches human level, there will be a positive feedback loop that will give the development a further boost' (*Express* Online, accessed 26/01/2017), safety measures are being built into devices and software just in case humans need to take control of a device that is misbehaving.

In this regard, as early as 1942, the science fiction author Isaac Asimov proposed a set of rules, also known as Asimov's Laws or the Three Laws of Robotics. The First Law is that 'a robot may not injure a human being or, through inaction, allow a human being to come to harm'; the Second Law is that 'a robot must obey the orders given by human beings except where such orders would conflict with the First Law'; and the Third Law is that 'a robot must protect its own existence as long as such protection does not conflict with the First or Second Laws' (Asimov 1950). These laws were central in *I, Robot* (2004), a movie which addressed the question of why a robot would attack its maker. Stephen Hawking has also warned us about the development of full AI, claiming it could spell the end of the human race (*BBC* online, accessed 27/01/2017).

The idea of being in control within the virtual clearly opens a Pandora's Box. Fear of technology getting out of hand is a topic of interest in literature and film, which depict the emergence of a dystopia that humankind must oppose, resist and stand against for the sake of something better. Fear, as always, does have a positive function, not only prompting us to be cautious but also functioning as a counterbalance to excessive enthusiasm and falling for promises that are impossible to fulfil. For the time being, the threat is first of all from other humans: US Cyber Command in Fort Meade, Maryland, has about one hundred teams actively involved in coordinating cyber defence (www.defense.gov, accessed 27/01/2017).

'Distributed denial of services' (DDoS) attacks are already a serious threat. DDoS attacks are illegally organized virtual events through which millions of computers are activated to send data to one address at the same time. Whatever activity is related to that address will drown in the data, become uncontrollable and no longer available. DDoS is brutal compared to the subtle methods developed to 'hack' systems, take control and make use of devices, hardware and software that are connected to the internet. While most people were aware of the possibilities to some extent, the Snowden files (the leaking of National Security Agency [NSA] documents in 2013) have been a wakeup call. They revealed the ambition of the NSA to develop the capability to monitor and analyse all digital information produced across the globe.

More locally unwanted and illegitimate interference can also take place, for example in relation to the ZigBee high-level communication protocol (conceived in 1998, standardized in 2006). This is a wireless bridge with a reach of 1–100 metres and for many years a common means of interaction for digital locks, switches, lamps and various other devices, all linked to the internet. The technological possibilities, the ethics that accompany them,

and the involvement of the authorities, supposedly the gatekeepers for the public, are now being blamed for illegal practices on a massive scale (*BBC* online, accessed 30/01/2017). These are nasty and scary developments in the digital jungle, which were meant to remain unnoticed.

What do these developments within the virtual world tell us? Do they undermine our assumption that hybrid space behaves like a complex adaptive system? We do not think so. They tell us that aside from enabling conditions, constraining rules, arrangements and conditions are desperately needed within a package called '*performance conditions*': the conditions giving expression to the dynamic and diverse world of the virtual (Table 1.1 and Figure 1.5).

These developments demonstrate that the virtual side does represent diversity and chaos in the hybrid space, in which the material side is by far the more stable of the two. Humans interacting with the virtual still have the material world very much as their base, with the support of which they act and behave, particularly in cases where joint efforts and sense-making are required. In those cases, reference is also made to more traditional institutional structures, for example the government system and its institutional structures, to ensure *behavioural conditions* are met: the conditions giving expression to dynamic activities within a relatively stable, reassuring material world (see Table 1.1 and Figure 1.5). The question remains: *How do we make the various conditions considered relevant within the hybrid world work?*

In theory, it is not about the virtual being good or bad, fearful or promising, but how it is used. It is also partly an ethical issue of dealing with the question of how to find a balance in conditioning the virtual and material, resulting in workable hybrid space. Conditions – as the acceptable and appreciated state of something with regard to its appearance, quality or working order, as well as the circumstances – have two sides, as they constrain as well as enable.

They will also heavily depend on how *the robust layer* (both existential and instrumental, see Table 1.1 and Figure 1.5) is developed and how it continues to develop. The instrumental conditions will partially relate to behavioural conditions in the sense that the virtual resonates with societal desires and objections. Society has its debates about what is appreciated, for example regarding privacy. This is a debate that resonates with what internet organizations consider feasible, and what democratic institutions consider acceptable. Here, there is a clash between privacy, market mechanisms, technological possibilities and collective freedom.

This brings us back to *the dynamic layer*, within which 'behavioural conditions' (Table 1.1 and Figure 1.5) are positioned, as these are fluid, interpretable in multiple ways and trigger a wide range of actions, including opposing ones. All in all, what counts for every new technology, counts for the virtual as well: what is most important is how we make use of positive inventions while trying to avoid the negative ones, and how we define positive and negative.

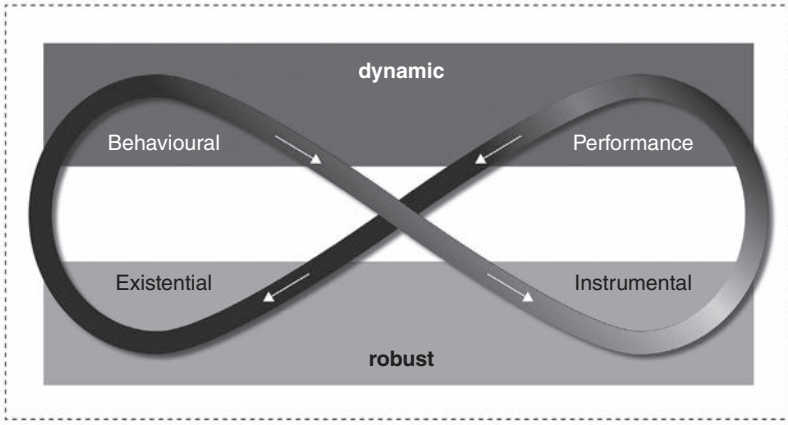

Figure 1.5 A potentially relevant procedural route that conditions hybrid space

This reasoning emphasizes the relevance of conditioning virtual space, generating counter-forces, and seeking a balance in the interdependent relationships between all the relevant conditions. This reasoning also sheds light on the question of how to do this. 'Behavioural conditions' are relevant in this respect, being a source of democratically produced institutional design that can counterbalance extreme or one-sided developments, for example those that are the result of market forces. Behavioural conditions are very much part of the societal debate, apparent in the convoluted struggle between the secret services, courts of law, politics and the public about the possibilities and constraints that the information age is generating.

Figure 1.5 presents us with a protocol for seeking a balance between the relevant conditions. It is one of many possibilities, but an obvious one: starting from 'behavioural conditions' (in terms of desires and objections) moving to 'instrumental conditions' (Is it feasible?) allowing the successful 'performance' (Is it appreciated?), which is likely to relate to human 'existential conditions', and so on. Here we have a protocol that supports the generation of the 'rules of the game' in a balanced way and to which the 'logic of instructions' of the virtual must apply.

Instructions generate the virtual, and the virtual generates instructions, and somehow both are human-oriented: instructions have no other intention than to be a function of human desires and needs. Nevertheless, the results of these instructions are events which we individually digest rather than making them subject to public debate. The institutional response to the virtual is often, if not always, a response to a development which is already beyond tipping point. This acknowledges the dynamics of the virtual, and institutions and institutional design will have to adapt to this dynamism.

Virtual instructions and digital algorithms create desires and needs until recently unknown to humankind. These unknown desires and needs feed

back from the digital into the social world. They are products of human beings making creative use of the possibilities offered by digital environments, digital networks, digital capacities and wide-ranging and highly innovative software. These are digital environments (SimCity, launched in1989; Second Life, launched in 2003; and Minecraft, launched in 2011) with conventions that enable and constrain. Digital environments and virtual space are a source of human creativity, even if we define these environments as 'computer-generated, persistent spaces in which users co-exist as avatars exploring, building, interacting, communicating' (Koutsabasis et al. 2012, p. 1). In other words, this is a creativity made possible by the profound effects of the information age on the social world. In particular, the user interface functions as the point of reference, the attractor to which digital instructions are oriented, and through which the user is addressed. And hybrid space between the material and the digital worlds is the place where it all happens.

Towards adaptive planning

Powerful developments are taking place within hybrid space. These developments are selective, fragmented and present biased perspectives on the mechanisms that are in motion. These mechanisms represent highly dynamic developments which will continue for a while more without end, and with no immediate understanding of what a more permanent and stable situation might look like. Nevertheless, various development paths have been recognized here, allowing one conclusion to be made regarding the material world: due to the virtual, we see the material space within which we operate as resonating with us. There is a *reciprocal awareness* of who we are, how we behave and what we appreciate. The space we use, occupy and make ours will increasingly be a place that has meaning to us in the way that it resonates, and with which we associate.

We will increasingly encounter space as aware of us, sensing us and responding, informing and adapting to us, on our command. Such an awareness is also based on our past behaviour and its relationship with the circumstances of the time. The way space responds might very well be without a precise idea of whether it is only in our interest, or also relates to the interests of others. Most likely it will be both, which is already apparent in the phenomenon called 'life(b)logging' or 'lifecasting': the perpetual sharing (24/7) of information with others about where we are, what we are doing, the emotions we are feeling, and who we have met. Such lives become an open book, free to be 'followed' by anyone interested in a life connection through the internet. Soon there will no longer be any need to take certain measures to make this work, with an 'aware' environment almost permanently monitoring who is around, with sensors and cameras everywhere.

We ourselves, our whereabouts and the rise of a reciprocal awareness that the space we are in is sensitive to us, our desires and wishes, will merge in some way. This will be a kind of 'surveillance', already described as 'sousveillance' (Mann et al. 2003), as we are not just subject to but participate in observations that we allow to happen in real-time, generating information for search algorithms to connect and to aggregate. For example, in the 'shared individual' experiment (Bombina Bombast theatre group, Malmö 2016), one individual takes over the 'senses' and the 'awareness' of the other, enabling that individual to observe him or herself through that other.

We assume reciprocal awareness between space, place, ourselves and the people we are with, and sousveillance will present us with a synthesis that can contribute to our quality of life. In concrete terms, we can take advantage of the home convenience system, which knows when we return home, what temperature we would appreciate considering the time of the year or the moment of the day, and taking into consideration the mood we are in, which results in subtle adjustments to the lighting system, background music, the presentation of the right scenery (wallpaper, pictures, paintings) and so on, meant to positively contribute to our way of life. The virtual will be able to generate a tailor-made environment which responds to us in the material world, while taking into account our mood, needs and desires in a dynamic and interactive way.

Which is all fine; however, the transformative process of a co-evolving virtual space is still continuing. Therefore it is yet impossible to have a clear idea about where this development is going, and to where it will lead. An additional difficulty is that the virtual is not easy to understand as a place based phenomenon. The information age is creating imaginary worlds that would be considered illusions in the material world. This is new, not at all common and it frequently surprises us, therefore making it hard to determine meanings, positions and developments regarding the virtual. The virtual is contextual and the context is highly unstable. Thus, it seems that the virtual is just 'happening' to us: it feels unstoppable, uncontrollable and does not fit into a traditional planned trajectory.

Therefore, there is a collective idea (that the 'system' is likely to know better and earlier that we do, ironically) about what the virtual means and what it does to public space. The impact of the virtual is subject to normative evaluation, and normative ideas are subject to politics, policy and processes of collective decision-making and planning, although not in the traditional sense, with a focus on control or consensus. How then to consider the ongoing trajectory within hybrid space from a democratic institutional perspective?

The virtual cannot be easily stopped from invading our lives and the public domain. Despite this intervening difficulty, a balanced relationship between the four conditions mentioned (Table 1.1 and Figure 1.4) remains relevant. Moreover, it would be advisable to follow a protocol as proposed in Figure 1.5. Perhaps we could go even further, by considering our collective

understanding of what the virtual *means to* us (appreciated – contended) and what the virtual is actually *doing for* us (enabling – constraining). Is it enabling societal development or is it a constraining or undermining factor? In certain situations, the virtual is appreciated for what it does in the material world, and can clearly contribute to societal development, with policy to support these developments further. In those situations in which the effects created by the virtual within the material world are contested, and these effects are seen by all as counterproductive, harmful or constraining societal development, policy can be developed to reduce, minimize or redirect the undesirable effects.

In traditional urban planning, space and place are conditioned by law and by spatial plans issued by a government or the authorities. In a way, conditioning space and place is done implicitly, and it is seen as a stable framework within which the planning game can be played. In highly dynamic times, with the context being influenced from all directions, triggering changes in space and place in the direction of the unknown, an entirely different planning game will have to unfold. Space and place will be conditioned actively and continuously. Consequently, what we might aim for is a planning policy that actively, and in a flexible way, conditions space and place, such that it supports or limits the impact of the virtual. This is what we might call adaptive planning (De Roo 2013, De Roo and Da Silva 2010, De Roo, Hillier and Van Wezemael 2012, De Roo and Rauws 2012, Rae and Wong 2012). Planning can do more than just coping. Awareness and understanding is one, adapting and balancing is second. And the identified conditions are a means to assure *a constructive kind of planning that relates to conditioning space and place* in support to societal wellbeing.

Conclusion

For spatial planning, does the virtual mean 'going down the rabbit hole'? Perhaps, as much has been left unanswered and untouched. However, here we have generated and constructed some proposals and a reasoning to cope with the material-virtual interface, which sheds some light on the issues. We have been able to construct frames of reference for spatial planning that can work in a world of ongoing yet discontinuous change, within which virtual developments occur, which are accompanied by uncertainties about what they will bring and what directions they will take us. This has led us to examine the conditions of this process, specifically, the conditions under which the transformations of hybrid space between the material and virtual take place. This undertaking was motivated by the idea that understanding the conditions can help us understand how dynamically unfolding developments take place, and get to grips with the hybrid environment.

The various conditions we have encountered relate to the physical, biological, social and digital worlds, and to the socio-technical innovations taking place within these overlapping worlds. Virtual and material spaces

are merging in a process that is still turbulent and full of uncertainties. For this reason, the ambition to frame hybrid space between the material and virtual has been narrowed down to the sketching of a framework for researching what types of impact the merging of material and virtual spaces may have on constraining and enabling conventions, on institutional design, on the transformation of space into place and on spatial planning.

The virtual world brings forth its own institutional design – the rules of the game – which is framed completely differently from what we are used to in the material world. Its impact on the material is exciting, diverse, dynamic, unstable and unclear. In various ways, the virtual is invading our daily environment and various aspects of our lives. However, these developments must be made to comply with us as users, allowing us to understand the virtual in such a way that it remains useful to us. Reference to physical, biological and social conditions remains a necessity. Our thoughts and our senses have to be able to relate to the virtual, and the virtual should present us with a suitable logic of space, allowing the use of (hybrid) space and the symbols and identities we relate to space and place. At the same time, the virtual can push us in new directions, teaching us to accept new possibilities, routes and alternative approaches. In particular, space and place can no longer be seen as static objects or constructs waiting for us to do something with or in them, instead becoming reciprocally aware of us as subject-participants, anticipating our needs and desires. This will be a major change which we will have to adapt to and comply with.

Conditions lead to conventions and to institutional design, framing our actions, behaviour and the way we purposefully intervene. With this in mind, the intention has been to grasp how the two colliding worlds (the material and virtual) can meet and create a kind of institutional frame of reference, emphasizing the relevance of understanding the 'conditions' under which hybrid space can evolve, in particular keeping in mind the turbulent times in the virtual world. The result is threefold.

First, we have delineated the conditions with which hybrid space – between the material and the virtual – has to resonate, such that hybrid space becomes the interface between the material and the virtual that 'works' for us as humans (Table 1.1 and Figure 1.4). These conditions frame development trajectories. Second, we have gained an understanding of the conditions of socio-technical innovations that lead to developments within hybrid space (Figure 1.1). These conditions frame the scope, development and route of a class of systems characterized as complex adaptive systems. Third, we have shown how a protocol or procedure can be deducted from these conditions, to which ongoing, discontinuous developments between the material and the virtual can be considered and evaluated (Figure 1.5), possibly even 'ex ante'. These three steps and their framing and conditioning potential are supportive to a kind of planning relevant in times that are unclear, fuzzy and dynamic…

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