Associativity and other Wurban Things

The Web and the Urban as merging Cultural Qualities

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Abstract—**Using the preliminary alignment of the concepts of the web and the urban as a starting point, this article explores the potential role of the notion of associativity as a theoretical term in discourses about the Web of Things. The urban and the web are regarded as different instantiations of a hypothetical entity common to both, the WURB. As an abstract concept, WURBs can be easily reflected by formal models such as networks or agent-based systems. We argue that this requires a substantial refinement of the concept of information. It is shown, how the concept of the WURB can be used to derive new approaches to old questions and new design tasks, which are both provoked by the notion of the Web of Things.**

Keywords-associativity, SOM, information,virtuality, urbanism;

I. INTRODUCTION

The World Wide Web is a cultural phenomenon which is developing at a tremendous speed, the Web of Things being just the latest of the concepts which are thought to be made possible by it. Many opportunities and risks are projected to the related and rapidly progressing technological developments. For a variety of reasons, ranging from allocation of financial resources to political and societal challenges, it is important to understand the particular quality and dynamics of web-related technologies.

The World Wide Web (WEB) did not fall from the heavens and the Web of Things (WOT) will not either. Our hypothesis is, that both, the WEB as well as the WOT, including all its secondary media as well as the internet as their infrastructure, could rewardingly be conceived as the successors or extensions of urban culture. We will show that despite their different evolutionary descent and pace, the "Urban" and the "Web" share important properties. It may well be expected that we can gain insights from that in either direction.

Since the first appearance of the city, the urban form of life has been proliferating so much, that today the notion of urban culture covers the majority of the dynamics of human culture. This success is not only reflected by the still unbroken attractivity of the city as a cultural model, it also may be regarded as the main reason for the prevailing difficulties to build a generally applicable theory about urban culture.

It is almost a truism to state that the phenomenon and effect of the WEB is based on the processing of information about things, whether material or immaterial ones. Technological developments will open additional channels into the world of information, for human beings as well as for devices. In this way, the Web of Things will certainly intensify the role information plays for the further evolution of human culture.

Despite this overwhelming role of information, it is much less clear how to conceive of it. Neither data, e.g. in the form of bits, nor knowledge can be equated with information. Likewise, it is also inappropriate to look on information as a kind of intermediate between data and knowledge. Information seems indeed to be attached to every "thing." Thus, any "thing" emanating from our cultural activities should be expected to be affected, transformed or even originated by the turn towards information. Hence, any understanding of the WOT is tightly related to the way how we conceive of information. For example, if we put entropy-based measures into that understanding, we will get returned some thermodynamical effects for the WOT. Yet, this may not be the desired outcome in a cultural perspective, which raises the question about how to think about and then to use the concept of information.

If we compare discourses about urban life in particular or even social life in general, lets say from the 1960ies with the contemporary one, the career of the concept of network is absolutely striking [1]. While some decades ago cybernetic function and control were at the forefront and the notion of networks wasn't in use at all, today nearly everything is labeled, perceived and conceived as a network. Yet, a network does not exist as a "real" thing. It is a concept, a structure, a theory which first actualized as a culture. The astonishing career of the concept should not taken as a kind of objectivism. We still lack a full understanding of networks, probably due to the potential relationship with complex self-organizing systems. It is perhaps even more striking, that discourses about networks in the context of the WEB, the WOT and the urban form of life as well are dealing nearly exclusively only about the logistic aspects of networks (see for an example [2]). Yet, certain networks develop a very important property: associativity. Our core hypothesis here in this paper is that the concept of associativity provides a significant contribution to the understanding of contemporary forms of life, whether based on the urban or on the web.

The latest concretizations of digital technology inverted an important aspect in the relationships between human self-conception and technology. Up to the end of the 20th century our imagination had always been ahead of technology. Human inventors always felt the constraints of the material basis of the then available technology, they always were thinking about devices and appliances not yet possible. Leonardo da Vinci provides us a famous example for this. Today, it is different. We are severely limited in our capability to think of possible usages of the soft—i.e. software based—devices we build. The role of design thus has changed markedly [3,4]. It is by no means an exaggeration to claim that the WEB and the WOT as well have opened up a largely unknown design space. A strong determinant of this design space is, again, the way of how we conceive of information, and furthermore how we should think about the control of things, especially where immaterial things materialize, or where material things immaterialize.

Yet, in this paper we will not delve deeply into design theory. Behind the scenes, we adopt the perspective which distinguishes design as a field clearly from art, science, artisanry, or engineering, its role being almost that of a medium for those other fields and its target being not objects and their materiality but instead the prespecific aspects of enabling object-related story-telling [3]. Our interests here focus mainly on the concept of associativity and its implications. We will propose to adopt a certain formal model for talking about the new design space, which has been opened by the turn towards information. This formal model is based on the self-organizing map, the SOM. The SOM can be interpreted as a mathematical model for the spreading of information across networked populations of populations, and the effects of this spreading. Thus it provides a basis to think about phenomena like the WOT or the modern city in a sufficiently abstract manner. Before introducing the SOM, however, we will briefly circumscribe the context of this formalization.

II. Mediagenic Devices: Cities, Webs

Much like human culture as a whole, urban culture unfolds largely in a space which is determined by two fundamental processes: the evolution of technology and the dynamics of symbolization. These processes provide immense effects and benefits. Yet, both processes are strongly fostered by a still more fundamental principle which is so ubiquitous, that it is easily overlooked. Cities are entities which develop a self-accelerating tendency of densification; consequently one could even look at them as centers of cultural gravity.

At the bottom line, densification is a trivial process. The effect of densification, however, is anything but trivial, regardless the systemic context and regardless the materiality within which this densification takes place. In the context of urban culture, densification, especially when reduced to the number of people per square meter, is known to be associated with instability. This idea of instability due to densification has been frequently used in arguments against urban life throughout history, beginning with Platon who argued that the best size of the city is shortly less than 10’000 inhabitants. The story about densification is, of course, not one of mass or numbers, but one of relations. This holds true not only for atoms and chemical elements, but predominantly so also for social contexts.

Densification of relations gives rise to the appearance of media [5]. A medium can be regarded as a transferring milieu. As such, it is by no means neutral concerning the message. Mediality, the abstract property of all media, can be conceived as the possibility for rule-based interpretation of density fluctuations within the milieu which transfers signals, or even as fluctuations of a probability. This applies to the relation between air and speech, between water and the singing whale, the newspaper and the stream of social events, or the relationship between comic or cinema and the ongoing negotiation about social archetypes. Literally every thing, whether material or immaterial, can become a medium. The only requirement seems to be a densification process up to the “point” where the duality between being matter and being the readily available material basis for the propagation of information appears. As soon as an immaterial thing becomes a medium, however, it often feels much like a material thing, probably due to the very fact of its infrastructural reliability.

Cities have been densification devices since their first inception. For the time being Manhattan may be viewed as the most developed state of densification. Cities provided the first breeding reactors for a variety of networks as well as for a whole range of new types of media [6], think for instance of the invention of writing or of the numbers in ancient Mesopotamia or the Mohenjo Daro site in Pakistan, or the development of facades from Palladio [7] until the media facades in our contemporary times [8]. On this line of media evolution Manhattan could be regarded as a kind of a 3D precursor of the WEB, built from stone, steel and glass, since it offers the same particular topological qualities [9]. As logistic devices, cities bring people, things and processes together. The same is true for the internet as a transmission infrastructure. Whether by means of spatial superposition or by very fast transmission, a factual densification takes place in both cases. Both, the networks of a city and the internet are fertile patches where media develop, grow and evolve: They are *mediagenic* devices.

This qualification does not need to resort to the purported “origins” of the compared entities, the cities, the WEB or the WOT. Their rich evolution renders any consideration of possible or factual “origins” to a subject for a town chronicler. Relevant for our arguments is just their contemporary property of being mediagenic. This very fact transcends the primarily logistic character of the city as well as of the internet. We have seen that media are immaterial phenomena. Media abolish the physical directedness of logistic pathways; they relate things which they embed probabilistically and in any direction. Media are themselves products and producers of further densification phenomena, which relate them to the concept of redundant networks as well as to that of information.

III. Information

Norbert Wiener’s statement established information as a well-demarcated category for the first time: “Information is information, not matter or energy.” [10] But what actually is information, then? Or addressed in a more feasible way, how should we conceive of information? Nowadays it is widely acknowledged that the sub-syntactical perspective of Shannon’s theory is not adequate for all the less reductionist applications of the concept of information. It is just useful to treat the propagation of errors in the transmission of a stream of strictly encoded symbols, and this certainly does not cover the concept of information as we use it today in so many instances.

Information is often regarded as a mental entity [11], and as such it being compared to knowledge. This concept is questionable, at least. Alternatively, it definitely does not help much to propose that information ought to be conceived of as a process, whereas knowledge is a state [12]. Langlois formulated a more differentiated position, stating that "meaning is a matter of form not of amount; and the value or significance of a message depends as much on the pre-existing form of the receiver as on the message itself. Information is stored as knowledge in a system [...]." [13] This conception seems to respect the primacy of interpretation [14], but it still expresses the content-related stance to knowledge and thus falls back into the strictly inappropriate pattern of assigning meaning to a difference prior to its evaluation. Philosophy and philosophy of science provide us strong arguments against the content perspective onto knowledge [15,16,17]. Interestingly, what is known in the HCI field as user-orientation or user-modeling may be seen as a response and a direct consequence of this basic inappropriateness. The resulting informational architectures are dramatically different to those following from other approaches. This example underlines the importance of philosophy in the fields of information or media technology.

Knowledge can not be equated with content, thus it can not be "produced," and it can not be stored either. Instead, we should see it as a capacity for translation between incommensurable complex systems, let it be different cultures or domains, or the transition between brain, thought, language and culture. Information about factual cases and information about the treatment of information can support us to extend this capability, but in any case such extended capabilities can neither be transferred nor implanted: They have to be trained and exercised. Additionally, the assumptions that meaning is a mental entity or that it can be assigned to whatever you like, for instance to a message, runs into serious troubles alike [18].

In the same way "information" can not be seen as something which is per se meaningful, as it has been assumed by early information theorists like Shannon when describing the so-called "information society" [19]. The fact that everything can serve as a bearer of information points to a complete dependency on the interpretation by an interpreter, whether this is a human being, a machine or a molecule.

Taking into consideration this primacy of interpretation, information then could be conceived as a way of speaking about the possibility of a differential and irreversible choice. Once an irreversible change happened in a rule-based way, i.e. differentially, we have actualized (some say "used") information. Information thus appears only in hindsight as a means to conceive just the fact of possibly different choices. Insofar it could be conceived also as a virtual entity. According to the philosopher Gilles Deleuze [20], virtual entities are fully real, but they need to be actualized. The philosophical notion of virtuality has precursors back to ancient Greek philosophy and equals almost the notion of potentiality. One can recognize easily the close ties between information as a virtual on the one hand and anticipatory modeling, simulation or rule-following on the other.

From this directly follows, that the impression of discreteness and clearness of digitally represented information is a delusion. Inasmuch as information becomes only definite within a completely defined context, e.g. a particular algorithmic process, or a closed code, it is even a dangerous delusion, since this assumption renders any participant, including any human being, into a programmed actor, a trivial machine.

Information relates in an interesting way to causality, which is a quite important aspect in a world with a web of things. Things can hurt physically, if they go wild. As long as we are within the world of information, it does not make any sense to use the scheme of causality. If-then statements and all the conditionals in language represent unique mappings, mirroring causality. Using them with regard to information is thus nothing else than a categorical mistake. To put it short, logics is not about information, neither is mathematics or geometry. Instead, we could use a concept from Quantum physics to describe this difficult relation. We could say that information decoheres into causality upon an irreversible change. Since there is no necessity in things of an informational world we need new ways of creating trust. One such way could be found in behavioral choreographies, which would be used as ritualized handshake procedures. Such choreographies are well-known e.g. from wolves [21] or from e-banking authentication procedures.

Quite obviously, the concept of information comprises some aspects which can not be reduced to one another. Since we actually do speak about storing information, processing information etc., we have to accept this common parlance. In order to reconcile those different aspects we could apply an Aristotelian trick, which nowadays is rather abundant in various sciences. We simply construct information as a multi-dimensional entity, just as Aristotle did for his conception of causality. While Aristotle distinguished four aspects of causality—causa materialis, causa formalis, causa efficiens and causa finalis—, we could perform a similar move with regard to information. In a rather speculative attitude we could propose to distinguish the form, the effectiveness and the extension of information. The *form* would tell us whether information is given in bits (like in bytes or language) or more as a whole (like an image) from which we have to extract parts, the *effectiveness* tells us about its reliability or certainty, and the *extension* is about the strictness of its encoding. We emphasize that this is a very provisional proposal, but probably it is a promising one.

To summarize the important issues of this brief investigation we propose that we should not mix the language games—or the perceptional schemata if you like—of information and causality. Information is the language game about the arrangement and the design of reversibility, while causality is the language game about lawful irreversibility. Causal chains do not share any point with the fields of probability where information resides. Most appropriately, information is conceived as a virtual entity, which can neither be produced nor be stuffed with meaning prior to being interpreted as a difference.

IV. NETWORKS

Any "population" of whatsoever type of relation can be called a network. There is a literally infinite number of different network structures. Yet, we would not call a simple binary relation a "network," and neither would we do so for a haystack. Many would even hesitate to call a hierarchy a network, despite the fact that any "network" without or with only very little redundancy is topologically equivalent to a hierarchy.

Networks should not be conceived as a particular form of a more or less (im)material grid. The key principle underlying the concept of networks is the informational superposition. Abstractly spoken, a network is made from a population of entities bearing some memory and a set of transfer functions. Where information is superposed, we could speak of "nodes," where information is transmitted and is passed through without leaving a trace, we can speak of "axons", or relational instruments. The parameters and the role of a particular element in a network can change randomly. The same holds for the connectivity and the projections of relational instruments.

If we take the topology as a quasi-physical measure, it is obviously quite hard to apply the concept of network in a consistent manner [22]. For our purposes, it is much more suitable to classify networks with regard to those properties which are relevant to their dynamic development or behavior. "Behavior" is related to their usage and as a metric to compare networks it creates two sharply separated groups, which we call the logistic and the associative networks.

Logistic networks are optimized. They minimize the time of transmission or the amount of matter needed to build them. Logistic networks tend to produce synchronicity, or in other terms, they extend the signal horizon as much as possible. They are even not medial, since it is expected that they perform their work completely neutral to the message. Much effort is spent to build them in a way such that they do not to remember the messages passed through. Logistic networks are neutral transfer machines, positioned completely in the realm of causality. Despite the fact that certain networks are known to be able to learn patterns, the vast majority of publications outside computer sciences about networks are just about the logistic aspects of networks, their geo-topological layout or their interconnectivity as a representational form.

Associative networks are quite different. They are working only in the realm of information. They are built upon a heavy redundancy of possible paths through their basic relational elements. They not only slow down any information passing through them, they even sort them, they reconfigure existing relations or construct new ones, while information flows through them. Associative networks assimilate; they are able to learn, which means to derive classes from observations for subsequent recognition tasks. One of the interesting things is that the associativity of networks is nearly inevitable, if its atomic elements bear some memory, even if their memory may be strongly limited to a few bits. Another relevant issue for our context here is, that associative networks are able to store any information regardless their own materiality. An associative network may itself be completely immaterial, yet it can still store and process information of any kind. Associative networks thus are a salient bridging principle between the material and the immaterial aspects of the world, which some call body and mind, respectively.

It is tempting to apply the concept of associativity to the urban context, and particularly to the rising Web of Things. Human beings, as well as all sorts of ICT devices and even buildings, bear some memory, they can relate to each other in "wireless mode." They can communicate using different modes including asynchronous blackboard communication. To conceive of cities by using a metric which includes associativity thus appears well-justified. Doing so, a whole range of new and interesting questions, challenges, opportunities and problems become visible, the most important question probably being: How to make the best out of this potential? The first step could consist of exploring a formal framework, which is sufficiently abstract in order to avoid reductionism. An example for such a reductionism, following the line of naive realism, is the attempt to explain and model urban phenomena completely based on just the physical layout of a city, i.e. the spatial arrangement of buildings and streets (for examples see [23,24]).

V. SELF-ORGANIZING MAPS, EXTENDED

Self-organizing Maps (SOM) are simulations of particular mathematical network structures which exhibit associativity. They are usually not classified as Artificial Neural Networks, since there is no direct representation of "neurons." This, however, is not a weakness, it is a strength. Its inventor, Teuvo Kohonen, explicitly tried to find an abstract representation of the phenomena on the level of whole brain areas, rather than simulate individual neurons [25]. Due to its structure and their inner dynamics, SOMs can be regarded as simulations of populations of populations. This makes them so attractive as a formal basis for any investigation of the immaterial associative aspects of urban systems.

In a SOM, nodes are more or less assorted populations. In the case of a SOM, "learning" means to sort different observations (items) into different populations (nodes) according to the determination of the similarity of the item to such a local population. While the SOM is collecting items, it distils increasingly homogenous populations. Thus the SOM provides an elegant mechanism for the progress from "cases" to "types," or from richly described individuals into assorted groups. This capability is mainly an effect of the way the nodes influence their close vicinity, for instance in a distance dependent manner.

So far, SOMs are used especially in the field of machine learning and data analysis. Its labeling as a "map" derives from their capability to project, i.e. to map, a highdimensional abstract data space—read this as compound or complex entities, e.g. human actors—onto just two or three dimensions This renders them into a suitable device for the investigation of complicated data and/or large amounts of data. The mapping created by a SOM preserves the topological relations between individual items represented by the data as far as it is possible under the constraint of reducing the dimensionality of the data. In the context of this paper, the outgoing dimensions can be directly interpreted as spatial dimensions in two or three dimensions. It is a special property of SOMs that they perform such a mapping by employing strictly local rules, e.g. how to transfer information between neighborhoods of nodes.

The original version of the SOM is not perfectly suited for our purposes for the following reasons: its topological properties are isotropic, and nodes do neither change their position, nor their quality. There is, however, an interesting kinship to another type of networks, which are much more volatile: The so-called Reaction-Diffusion Systems (RDS). RDS are a model to describe self-organized emergent patterning and morphogenesis. First proposed by Turing in 1952 [26], there are further basic types known today [27,28]. The basic structural property of RDS is their self-referentiality, expressed as a set of auto-catalytic or cyclically arranged reactions. In RDS, we find agents in a dense population which move freely around and which behave according to strictly local rules. Different types of agents react with each other, producing further agents, which in turn react into agents of the first kind. As a result, a deeply complex and dynamic spatio-temporal patterning occurs regarding the distribution of the different kinds of agents. These patterns are only dependent on the reaction kinetics and the diffusion constants, but they are not dependent on the particular type of agents involved. It is important to understand, that the spatio-temporal assortment in RDS is fully emergent. The pattern is not and can not be pre-programmed on the level of the underlying materiality.

The kinship between SOM and RDS is quite close. Both systems are probabilistic networks, for which it is not suitable to apply causality as the only onto-epistemological category. Hence, we propose to extend the standard SOM architecture by structures from RDS, which allows for a self-organized differentiation of the roles of its nodes. In order to convert a SOM into an RDS, we just need to introduce a diffusion constant and a kinetics constant as a variation of the transfer function of the SOM. The diffusion constant may be regarded as something like an abstract temperature. Melting a SOM results in a RDS. This relationship is subject of ongoing research from physics to biology and computer sciences [29]. Given the complementary roles of SOM and RDS in the twilight zone between causality and information we propose the concept of an extended Self-organizing Map as a formal model for associativity phenomena in cities and webs. The dynamics of the RDS then would represent the wave-like dynamics, i.e. the dynamic spatio-temporal distribution of parameters which are governing the memory properties as well as the mobility of nodes, which are representing groups within a population.

Such models can be used either as a standardized base for simulations or as metrices to compare different configurations of cities or webs, e.g. in the context of urban planning. In this way, the approach of using the formal model of extended SOMs also could provide a framework for a common language suitable to speak about immaterial phenomena in cities and webs. Real-world examples for such phenomena are memory effects, which can block the development of a particular quarter, or the ability of the city to invoke a particularly dosed mixing, assortment or separation of sub-cultures within the city. Both aspects are rather important for urban planning. It is thus important in turn to understand the influence of the Web of Things upon the associativity of the city.

VI. The WURB

Cities and the WEB share a lot of properties. With the help of the WEB, those properties, like a multitude of volatile social relationships, can be experienced far outside of the next available city. Both entities are mediagenic, and both develop associative networks, which could be simulated by the same formal model, the extended SOM. Of course, the differences prevail, the comparison leads us into abstraction. We can, however, very well assume a Deleuzean differential entity [20], an abstract entity, from which both types of entities, the city with its networks and media as well as the Web could be instantiated. This instance we call the WURB. However, relating the urban and the web requires such an instance.

Today, in the advent of location-based services and the WOT, it seems more than reasonable to drop the strict separation of cities and the WEB. Refusing this merge, one would be enforced to reduce the phenomenon "city" to the built matter. Of course, urban planning just referring to the built matter falls short of most of the cultural aspects, which determine the quality of life in a city. In order to compensate, a lawful relation between spatial organization and the immaterial qualities, and consequently also between the form of built matter and further development of the city has to be proposed (for an example see [23,24]). It is clear, that such reductionist approaches are not only insufficient. Concerning their role as constraints to cultural development, they are even dangerous.

Dropping the strict separation of cities and the WEB and employing the concept of the WURB instead unlocks completely new modes of interpreting the urban life forms as well as the various phenomena in the WEB. It also provides a historical continuity even for the most recent phenomena. This can provide helpful insights for any design task.

VII. Smart Activities

Outside a marketing-oriented vocabulary smartness is closely related to anticipatory adaptiveness. This includes the mandatory capacity for autonomous modeling and in turn for performing ongoing measurement. Things like logistic networks can be smartly engineered and arranged, while the entity itself, the logistic network itself remains completely dull and without even the smallest piece of memory. The telephone cabling network or the internet will not develop "smartness." Other types of things like associative networks need not and can not be fully engineered and yet they develop the capability to re-associate things or pieces of information. As an effect, they create particular assortments or sortings and behave adaptively as a result of a somewhat natural process. Systems of the first type stick fully to a "fixed-wiring" model following the lock-and-key principle. Despite the fact that it may exhibit a variety of outputs, we justifiably hesitate to call such an organization of behavior "smart" or "adaptive." In fact, the input-output relations as well as all patterns made possible by them are completely pre-programmed in this case. Yet, smartness and "intelligence" can not be programmed as this would simply set up a self-contradiction. From a design perspective thus the question arises of how to deal smartly with the phenomenon of smartness in the context of wurban instances.

On the larger scale of the city the notion of smartness is often used in the sense of avoiding the various drawbacks of urban densification. In order to achieve the effects of smartness by applying the paradigm of complete or centralized control a tremendous effort has to be spent. Else, the problematics of massive surveillance appears on stage. This is not only strictly incompatible to the societal expectation of the possibility for participation. It is even impossible as a program since smartness, cities, the WEB and the WOT are informational entities which can not be described or even instantiated by causality-framed control.

If, in contrast, a decentralized model of control is preferred, e.g. for political reasons, then there are two alternatives. The first one would draw on enlarging and densifying the population of logistic machines. This would lead to a system-immanent associativity as we have been discussing it before. The second alternative would develop devices, things and processes which themselves are smart, which means autonomous, at least partially. There is no "intelligent" or smart behavior without autonomy as part of the agency. Clearly, it can not be strictly controlled any more. Note, that the concept of associativity as we are proposing it here is very different from that of "collective intelligence" [30], which does not consider the additional and emergent layer established by associativity.

VIII. Conclusion

In this paper we have argued to consider cities and the WEB as instances of an abstract entity common to both of them, the WURB. WURBs appear as a consequence of the explicitly chosen turn to information as an epistemologically constructive principle. The realm of information in turn is the home of the phenomenon of associativity. We propose to use the concept of associativity as an operator instead of considering it just as an interesting phenomenon, cultural or otherwise.

Using associativity as an operator changes the way we think of the city and how we can conduct urban planning in the age of the WEB. Of course, solving logistic challenges will still be a necessary task, but the much more interesting issues are about designing and calibrating the associative strength of various neighborhoods of a city. Using the paradigm of associativity, we can start to design the memory properties of urban neighborhoods. Not the movement of atomized people in various kinds of metallic boxes will be of top priority, but the capability of the city to assort, create or abolish certain subcultures. The WURB and associativity allow addressing the differential allocation of informational and even physical resources on the supra-individual level of the city as a whole.

These processes can not only be simulated with falling into a materialistic reductionism, they can even be implemented in an empiricist manner. The paradigms of associativity and the WURB offer a dedicated way to think about the role of location-based services or new ways of presenting the urban processes in the WEB. The WURB vaporizes categorical gaps in the discourse about the networked and mediatized contemporary forms of life. In such a setup, both the real and the virtual world would function as a distributed reference in a mutual way. The associativity of urban networks itself would be rendered visible, thus possibly becoming a subject of socio-informational behavior, i.e. of symbolization processes. In fact, a pilot project of our group called "AvaGarden" already demonstrated the feasibility of the approach on a small scale [31].

WURBs and the associativity of "actors in a network" [32] are new conceptual tools for planning and design of and in networked environments. Much (design) research remains to be done, of course, in order to exploit the full potential of these tools and to determine the relation to other frameworks and fields.

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