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# Citizen-Centred Design for Humane and Sociable Hybrid Cities

Norbert A. Streitz
Scientific Director
Smart Future Initiative
Frankfurt, Germany
norbert.streitz@smart-future.net

**Abstract.** This keynote addresses opportunities and risks of smart hybrid cities. Contrasting the mainly technology-driven approaches, a citizen-environment-interaction perspective for the challenge of urban life management is presented. The proposed people-oriented, empowering smartness design approach where "smart spaces make people smarter" by keeping the "human in the loop" allows also to support privacy and informational self-determination. The paper builds on a vision for reconciling humans and technology by arguing for a citizen-centred design resulting in Humane and Sociable Smart Hybrid Cities.

Keywords: urban age, smart city, hybrid city, humane city, sociable city, citizen-centred design, experience design, human-in-the-loop, privacy, transient spaces, location-based services

## I. URBAN AGE

We have entered the 'Urban Age' with more than half of the world population living in cities already in 2008. According to the United Nations, word population will rise from 7.2 billion (in 2013) to 9.5 billion in 2050. At that time, around 70 % will live in cities with the growth taking place especially in Asia and Africa. Population in cities will rise to about 6.5 billion in 2050.

Cities have been and will increasingly become the central hubs of determining life in the 21th century, especially in terms of providing opportunities. This results in an increased influx of people moving from the rural areas to the cities in order to live their "dream of a better life". With more than 50% of the population living in urban contexts, cities are being confronted with huge problems. One has to distinguish between different developments of the resulting 'megacities': areas as, e.g., Tokyo, with a good, sometimes high-technology infrastructure and numerous work and creative life opportunities are in contrast with megacities as, e.g., Mumbai, with insufficient infrastructures, slums, etc. combined with disappointment, because expectations about the opportunities were not met (only low-paid jobs exist).

While this context is always to be kept in mind, the focus of this paper is the role of information and communication technology for designing smart cities. Of course, there is a wide range of other issues as, e.g., socio-economic aspects and issues with respect to implementing ecological, sustainable, green cities. They are very important but beyond the scope here. Furthermore, it should be made clear that smart cities could be one way of addressing some of the problems of the urban age, but it is only one perspective and not a solution for all of them.

## II. SMART, HYBRID CITIES

The notion of a 'smart city' has too many facets to be covered here. I can only highlight a conceptual framework with some examples in order to stimulate a comprehensive holistic view. There are many individual, often separated activities that contribute to the overall 'smart city' agenda.

There are different usages and concepts associated with the term 'smart city': Digital or also Virtual City which is an early notation for virtual worlds (e.g., Second Life), usually without concrete relations to 'real' physical cities; Ubiquitous City (or u-City) with the primary focus on technology and infrastructure; Green or Sustainable City, where 'smartness' is being used with respect to ecological and environmental aspects.

The Smart City, I am referring to in this paper, is based on the deployment of information and communication technology (ICT) for its realization. By putting pervasive computing and ambient intelligence infrastructures in place, urban environments are transformed into interactive spaces that are meant to be adaptive and smart. Combining information and experience spaces with ubiquitous computing in urban context results in what is being called 'smart cities'.

Hybrid City is another term being used, also in the title of this conference (http://uranus.media.uoa.gr/hc3). I appreciate the choice of this term very much, because it reflects also my understanding that we have to address the connection, balance and interaction of real worlds and virtual worlds, if we want to get the full picture of what is relevant for the design of our future cities, resp. for the city of the future.

## III. Design Goals and Values

There are many ways of addressing the challenges and issues of designing our future living and working environments. The question, we have to ask, is: What kind of world do we want to live in? In a technology-driven and device-dominated one? Probably not!

The goal of designing future and 'updating' existing cities should be: *A Humane Sociable (smart, hybrid) City reconciling humans and technology*, allowing

- citizens to exploit their individual, creative, social and economic potential and to live a self-determined life.
- to motivate citizens to get involved, to understand themselves as part of a community, and to be actively engaged by contributing to the public good and welfare (collective intelligence, aspects of the Greek 'agora').
- to meet some of the challenges of the urban age by enabling people to experience and enjoy everyday life and work.
- to establish enabling but calm technology that supports and respects individual and social life by keeping the "human in the loop".

## IV. Design Approach

The overall design approach that I have propagated and employed over the last 30 years is a people-centred design of information, interaction and experiences and to "keep the human in the loop". One has to observe and maintain an interaction and balance of mental structures (cognitive, emotional), information structures, social structures and architectural structures which refer in this context to the physical built environment. This requires interdisciplinary teams with backgrounds in computer science, electrical engineering, product and graphic design, art, architecture, psychology, sociology, economics.

As part of the development towards an experience economy, an important change of emphasis took place over the last 15 years, i.e. the shift from information design to experience design. Designing experiences and controlling them became the relevant goal orientation. In this context, one has to distinguish between 'direct experiences/ perceptions', using our human senses, and 'indirect, mediated experiences' by making 'invisible' phenomena 'visible/perceptible' by mapping parameters on modalities accessible to the basic human senses.

A classic example arises from physics, where the level of radioactivity is measured by the Geiger-Müller counter where the output can also be communicated via auditory/sound feedback. A similar approach has been used in information technology, where, e.g., the amount of traffic on a computer network was mapped on sound samples of street noise.

The next step is to aggregate parameters in order to convey higher level concepts (e.g., activities of a person, atmosphere or ambience of a space, a building) or even to communicate social experiences (e.g., awareness, connectedness).

The underlying idea of this paper is that human-/people-centred design principles that have proven useful can be applied here as citizen-centred design. But one has to keep in mind that the smart city poses also new challenges. Smart city design should be a well-defined problem, but – unfortunately – it is an ill-defined problem due to multiple vested interests.

Economic prosperity and quality of life will largely depend on the ability of cities to exploit their full potential. In order to design it, it is important to explore the type and range of different activities in urban environments. At the same time, contemporary life styles become less focused and increasingly multidimensional. People's lives are taking place betwixt and between multiple offers and options. People's roles change within short time frames due to parallel activities in co-located situations. The public dimension of cities can be characterized to a large degree via activities taking place in 'transient spaces'.

## V. Infrastructure and Opportunities

The basis for designing a smart city is, of course, to establish an ICT-infrastructure that allows augmenting all kinds of physical objects (including humans, animals, plants) in the real world. Beyond having different types of connectivity (wired and wireless networks) in place, the emphasis is on attached or embedded sensors and actuators and - at a more advanced level (see below) – integrated smart materials. This infrastructure is also known as the Internet of Things (IoT), by some also called Internet of Everything (IoE). It is well-known and will therefore not be described here in more detail, except for one comment.

Towards Smart Ecosystems: while the current approach is mainly determined by embedding individual sensors and actuators, I propagate and predict a shift towards a computing, communication, sensing and interaction substrate that can be handled at the application or domain level. Examples would be smart table-cloth, smart wall-paper and smart street-surfaces. This requires a seamless integration of components with a high degree of diffusion which would lead to an 'emergent' smartness of the overall environment that might soon parallel other existing ecosystems. Especially in the context of a smart city, the computer as a 'visible' distinctive device disappears, either physically due to being integrated in the environment or mentally from our perception [4], [5], providing the basis for establishing a calm technology.

Within the urban environment, data are collected, aggregated, evaluated, and processed in multiple ways. The resulting data facilitate creating knowledge about citizens, states of existing objects and their changes (devices, smartphones, vehicles, streets, parking lots, shops, restaurants, hotels, office buildings, public and semi-public spaces, infrastructures, etc.).

On the basis of collected and processed data, smart services are being provided as offers to people based on

a combination of personal profiles and interests via matching processes with options and possibilities that are available at these places (location-based services).

As mentioned before, the public part of urban environments (streets, places, buildings, shopping malls, train stations, airports) can be characterized as transient spaces. They offer also the option to orchestrate them by different media resulting, e.g., in media façades.

## VI. APPLICATIONS

There are a number of applications that can be considered as examples of functionalities one expects from a smart city. In this context, 'smart' often means adaptive, personalized, location-based service. Central issues of the smart city are the implications of profiles and tracking data for designing mobility and logistics. Thus, it is not surprising, that many smart city applications deal with public and individual transportation (optimized bus routes; smart navigation; autonomous driverless cars) smart streets (adaptive lighting, solar roadways: www.solarroadways.com, adaptive tolls), smart parking (on- and off-the-street based on different monitoring and scanning methods resulting in adaptive parking space recommendations).

Another central aspect is that the 'smartness of a city' can also be characterized by how much the city knows about itself and how this is communicated to the citizens. Examples are feedback on air and sound pollution level in the city, respectively in the local space around my current location. Providing awareness and experiences in public spaces is one way to convey the status of the city which in turn requires exploiting different human senses (e.g., visual, audio, tactile). One can use different ways of communication: information by posting real time data on websites, using ambient displays in transient public spaces, providing personalized/ individualized awareness, using visual information via overlay displays (e.g., augmented reality type glasses), using local sound (in earphones) or tactile hints using vibrations conveyed by your clothes.

At a larger scale, media façades on buildings or even cooling towers of power plants (e.g., in Brussels) provide numerous opportunities to communicate content to the citizens passing by or even having them actively involved in determining and shaping the presentations via text messaging, a web interface or even a physical manipulation device. Here, the often more conceptually used term "the city is the interface" [1] actually gets real.

Collecting the necessary data can also involve the active and consenting participation of citizens and local communities as in the 'civic computing' approach. A good example is the work by Konomi et al. [2] on measuring urban congestion in trains of the Tokyo subway system. It is combined with a clever approach of using indirect measures (the $CO_2$ level in the train compartments) for determining the congestion level.

## VII. PROBLEMS AND RISKS

It should be obvious to everybody that the smart city approach highlights again the already existing dependency on a working ICT-infrastructure increasing it to a yet unexperienced degree. Besides having black-outs of the underlying electrical power grids, hardware (servers, networks, sensors, actuators) and software failures will also result in the loss of data and breakdown of functionality, e.g., identity recognition in the smart building does not function anymore, assignment of wrong data to people (due to data base errors), etc. Another risk dimension is security, including 'standard' criminal manipulation, but also political, military, terrorist motivated cyber attacks; and the new credo that all data are supposed to be in the 'Cloud' contributes to many of the security risks.

The third major risk for the citizens of a smart city is the loss of privacy in terms of losing the control over their personal data. The current discussions on privacy focus mainly on situations in the virtual world (misuse in social media networks). The more prevalent issues will surface in the smart city context concerning the personal data of citizens in the real, resp. hybrid world.

## VIII. SMARTNESS WITH HUMANS IN THE LOOP

When discussing 'smartness', I like to distinguish between "system-oriented, importunate smartness" and "people-oriented, empowering smartness" [3]. The first refers to the more or less automated or even autonomous behaviour of a system based on a set of collected data. Take the smart home (formerly home automation, domotics) as an example. It became soon clear that the 'smart refrigerator' had limitations, e.g., it ordered depleted items although they would not be consumed due to reasons beyond the refrigerator's knowledge, such as unanticipated absence, illness, etc.

In order to remedy the problems of proactively driven actuators, we propagated already some time ago the "people-oriented, empowering smartness" [3], which implies that the system is not automated or autonomous, but that the *human is in the loop* comparing several options and then making the final decision, partly based on suggestions from the system. The implication of "keeping the human in the loop" can also be stated as "smart spaces make people smarter", because people can base their decisions on the data collected and processed and thus take more mature and informed actions based on recommendations and suggestions of the system. This approach is getting increasingly popular as work on soft actuation in pervasive computing shows. But there is a caveat to it: How much feedback do we want? How many data can we process? At which level of the data collection and aggregation process do we want or are we able to be involved? As often with this kind of dichotomies, there is no either-or. In the end, it will be a combination of some degree of automation and pre-processing followed by human decisions and actions. The important point is that human intervention and control is possible, i.e. the data belong to the people, and the degree of automation is configurable by the human.

## IX. PRIVACY

Beyond the issue of having the human in the loop, there is a tricky trade-off for creating smartness. A smart system will usually be smarter with respect to a service offered if it has more knowledge about you compared to

a system with no or insufficient data about you. Thus, there is an interaction and balance between being able to provide smart support based on collected and processed data for selecting and tailoring functionality to make the system 'smart' and your right - in general the right of citizens - to be in control over which data are being collected, by whom, how they are used, i.e. the issue of privacy.

As a side comment here and to be discussed later, it is interesting to observe that many people are willing to provide their data for certain benefits (e.g., loyalty/ payback cards, sweepstakes, lotteries, and more recently fitness/ smart health apps).

Besides the principal privacy aspects, there are obvious design issues and implications for privacy: How can people know what is going on, when they are not aware of it, when they cannot 'see' the different sensors, the manifold devices distributed in the environment? Thus, we argue for so called Privacy Enhancing Technologies (PETs) [4] and for making them a standard part of system design by addressing the conflict of unobtrusive data collection/ provision with human control and attention in an open fashion and at an early stage of design.

Privacy used to be a legal and moral right and in many cases a socially negotiated feature. Now, privacy is turning into a commodity you pay for and you can trade – with the implication that privacy is becoming a privilege. In many cases, people are not really aware that the loss of their privacy is the price they pay for a seemingly free product or service, because they pay with their data. When discussing privacy, one should distinguish two aspects: Outgoing data (being collected via logging, tracking, surveillance) vs. incoming data (resulting from intrusion, unsolicited communication). Both aspects have different but severe consequences.

Although privacy is already an issue, it will become even more important in smart urban environments. While in the virtual world, you can – to a certain degree – still use fake identities and anonymization services, it will be more difficult to achieve this kind of disguise in the real world. The data that exist about you in the virtual world are now complemented and augmented by real world data and vice versa. Cameras are showing pictures of you entering a building, a shop or a public space with known locations, while face recognition identifies your personal identity. Real objects you are wearing, carrying, using, buying will be recognized by sensors in the environment because they are tagged.

The bicycle or car you are driving is a tagged object broadcasting its location and properties resulting in trajectories of your driving; but also your walking behaviour is transparent when carrying a smart phone (based on radio signal multilateration or GPS). It will become more and more difficult to avoid all kinds of object and related person tracking, because soon all objects and their parts will be tagged and respectively have integrated IDs. This is also the result of another development under the name of 'digital/ semantic product memory' which, on the other hand, can have advantages for consumers due to the principal availability of data about the origin of the product, the history of transportation (was the cooling chain interrupted or not?) and other valuable information (does this food cause allergies to some people?).

Location-based services in a smart city exploit not only your location and preferences but can be used to build up a complete profile of activities by monitoring what you did (e.g., buying goods, eating food, looking at public displays/ads, contacting people, …), when and where, including also other people present or involved in the situation. Unsolicited offers and advertising on your mobile phones and soon on public displays you are looking at, may compromise your preferences in public to people around you. This future predicted for 2054 in the movie 'Minority Report' (created in 2002) seems to be close.

As a final comment, nobody really knows what is happening or can predict what will happen to all the data generated in the real environment and then stored up in the 'clouds' of numerous service providers and manufacturers. In some cases, they are even voluntary uploaded by the citizens, be it their unsolicited 'selfies', general pictures, videos, augmented glasses views and recordings of their activities or their health data as part of a fitness or 'quantified self' app. In other cases, citizens seem to have no choice anymore when using many applications. Data exchange or synchronisation between devices is only possible via a cloud service.

## X. CONCLUSIONS

The smart city proposal provides many opportunities but also risks which require weighing the pros and cons. The proposal will only survive and be successful if our future cities are designed as Humane Sociable (smart, hybrid) Cities reconciling humans and technology. This includes to start or to revive activities taking a stand for personality rights, privacy and data security, in Germany known as 'informational self-determination', so that data belong to the citizens. This claim will be more than a liberal rights movement as some might denigrate it. I am convinced it could even be an advantage, a USP (unique selling proposition) in the global market, where Europe could take a lead by reflecting on its basic democratic and ethical values.

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