7. Discussion and perspectives

This final chapter both summarizes the results and contributions of this thesis, and discusses their relevance, context, and limitations. Each open issue and challenge calls for further research that we describe.

7.1. People as sensors; people as actors

The ubiquitous technologies that afford us new flexibility in conducting our daily activities are simultaneously providing the means to study our activities in time and space. In February 2009, Flickr broke the Hundred Million georeferenced photos count (over a total of 3 billion photos in the repository). This represents an unprecedented amount of publicly accessible data produced through people's interactions involving the web and mobile devices. In this thesis we have explored how the logs, fruits of these interactions, could reveal elements of human and social use of the ubiquitous technology itself (Chapter 2, location-awareness and collaboration), and people's mobility and travel behaviors (Chapter 4, air passengers experiences; Chapter 5, tourist dynamics). These latter evidences could be employed as indicators of the evolution of the attractiveness of the urban environment (Chapter 6) amongst other things.

We also focused on the human side of these data. Besides acting as sensors of individuals and groups' presence and mobility, they are often produced intentionally. For instance, users uploading of georeferenced photos can be seen as an act of communication with a goal to share or index a specific moment in space and time. This "I was here" brings a notion of subjectivity to the relation of people with space and place (Dourish, 2006). The effort of an individual to take a photo, select it, upload it onto a web-sharing platform and georeference it can be more powerful than any survey or GPS log that researchers interested in human space-time activity could access in the past. Therefore, automating this process could harm the richness of this explicit interaction with geoinformation. We have observed this underwhelming effect of automation of location disclosure in our pervasive game, CatchBob! (Chapter 2). People are actors, generating voluntarily (or not) digital footprints and they use ubiquitous geographic information to take decisions. Another human side worth stressing is that the integration of location-aware systems alters the relations of humans with others and with the environment. We have described evidences of strategies based on the knowledge of the space and the shortcomings of the system to take decisions (Chapter 3, taxi drivers). For instance, one of the taxi drivers described how he would follow his instinct and start to "improvise" and depending on the circumstances, when a conflict emerges between his navigation system and his intuition, revealing how location and opportunities determine the action as theorized by Suchman (1987). In our context, the understanding of the limitations and the imperfection of the technology seems part of the knowledge. Similar strategies emerged to handle the spatial uncertainty present in our pervasive game (Chapter 2, CatchBob!). People adapt to the technology, but also adapt the technology to them, for instance by integrating it into an ecosystem of artifacts to support their navigation and knowledge of a city (Chapter 3, taxi drivers). These early adopters of ubiquitous technologies act within a co-evolution process with their navigation system.

7.2. Discussed summary of the contributions

This thesis contributes to a thorough understanding of different aspects of the explicit and implicit human interactions with ubiquitous geoinformation, particularly the effect of the fluctuating geoinformation quality on the interaction with location-aware systems; and the effect of the human interactions with location-aware system on the ability to detect movement and presence in space and time. At this stage we could rephrase with more detail the introduction, which summarizes the main contributions of this thesis. But this detail is already present in the contributions of each paper in the previous chapters, and thus it seems more appropriate to stress and discuss some aspects taking an "overall scale" point of view.

Our methodological approach used qualitative, quantitative and design science research to produce guidelines as well as more factual knowledge. It is based on an interplay of techniques and results linking the case studies (Figure 3). Let us stress that the varied approaches applied to varied problems strengthen both the methodological approach and the support for the more factual knowledge evidenced. For instance, the mixed research method on our pervasive game (Chapter 2) informed the data collection matrix of the ethnographic study (Chapter 3). Similarly, the development of a replay tool to analyze the quantitative data (position logs) of the game participants built the experience on handling digital footprints with fluctuating positioning quality. It helped to identify sources of uncertainty from patchy network connectivity that inspired the design of an algorithm that takes advantage of the cold spots in wireless coverage to detect mobility (Chapter 4). This approach was further explored with a design science research method through the analysis of different types of digital footprints generated during implicit and explicit human interactions with wireless infrastructures or mobile devices (Chapter 5 and 6). Across these case studies we have covered many aspects of explicit and implicit human interaction with ubiquitous information. We believe necessary to discuss the main aspects in this subsection.

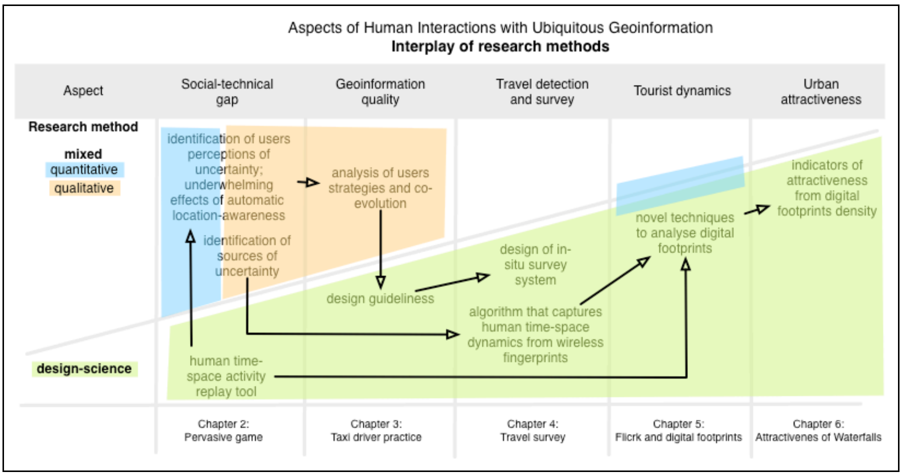

Figure 3. An interplay of research methods: the varied approaches applied to varied problems strengthen both the methodological approach and the support for the more factual knowledge.

Aspects of imperfections as the routine part of the convenience of computers

Although most people do not read the terms and conditions they agree to when using licensed software, they are willingly accepting an imperfect product whilst abrogating the supplier from responsibility for any damage caused. These imperfections in terms of bugs, glitches and crashes are at once notorious and yet also largely accepted as a routine part of the 'conveniences' of computers (Dodge et al., 2009)

We have seen that the fluctuating quality of the geoinformation people produce and handle plays a central role in their user experience. With the deployment of a pervasive game we could detect the sources of the imperfections from the supporting technologies and set some guidelines. More importantly, we could observe the players' reactions to spatial uncertainty (Chapter 2). We further analyzed this social-technical gap in real-world settings with taxi drivers when these reactions turned into strategies (Chapter 3). This presence of uncertainty impacts the learning process of the city that drivers sustain with an ecosystem of information sources. It also forces them to build skills to assess the quality of the geoinformation delivered by the in-car navigation system. These uncertain situations, that contradict the main purpose of the purchase of a navigation system to relieve drivers from their stress - made us propose the use of seamful design approach; an approach to reveal the state of the system rather than hiding it as proposed by others (Benford et al., 2005). We believe that these design guidelines promote the appropriation of technology and help reduce the social-technical gap generated by the limitation of technologies to produce the expected and humanly appropriate granularity of geoinformation. At this stage, these guidelines call for more empirical evidences. Taking into consideration the limitations of the technological settings is the source of another design solution as we demonstrated in our system that detects air travels from the full complexity of human and technological environments (Chapter 4). The emerging patterns of the data tend to reduce this perception of uncertainty as erroneous data get masked by the mass of valuable data (Chapter 5); this considering that the techniques to analyze the data (i.e. interpolation) do not distort the phenomena under observation (Chapter 6).

Aspects of clumsy automation

The massive amount of digital footprints is a manifestation of the increasing simplification and automation interactions with computers. For instance, our third case study (Chapter 4) that automated the air travel detection relied on the implicit interaction of mobile phones with the wireless infrastructure. However, over the years, the literature has discussed many examples of design errors of automating interactions (e.g. in aircraft cockpits, space mission control centers, and operating rooms; see for instance Woods, 1999). Our work suggests some dangers of, and solutions to "clumsy automation" in the context of ubiquitous geoinformation. In our third case study (Chapter 4), the travel detection algorithm did not completely remove the chance of false positives (i.e. the user has not taken the plane, but the algorithm detects a flight). In addition, the system requested the explicit consent of the traveler to communicate any information. These design measures were meant to respect the participant's privacy and keep him or her slightly aware of the survey. Indeed, applying a perfect algorithm might have an underwhelming effect on the involvement of participants completely forgetting about the survey. This insight was supported by our first and second case studies (Chapter 2 and 3) by showing evidences of the underwhelming effect of automating the disclosure of geinformation on collaboration, social interaction, and learning process of the environment. The alteration of the learning process does not necessarily imply that the integration of ubiquitous geoinformation has a deskilling effect. Indeed, users rely on other sources of information and social interactions when the automated process fails to deliver the expected quality of geoinformation. Finally, other aspects of human interaction with ubiquitous geoinformation can suffer from clumsy automation. We have discussed the richness in explicitly generated digital data as they hide intentions that bring a notion of subjectivity to the relation of people with space and place. This subjectivity is crucial to reveal tourist dynamics (Case study 4) or urban attractiveness (Case study 5).

Aspects of human-time relationships

The ubiquitous accessibility and generation of geoinformation ubiquitously creates an opportunity to infer or predict events in real-time as instantiated in the travel detection case study (Chapter 4). In addition, the ability to log interactions calls for the end of our ephemeral relation with space. Indeed, only a few years ago, the possibility to produce fully dynamic time-space diagrams from the fusion of human activities data and novel forms of geovisualization, was only discussed in the conditional. For instance Zook et al. (2004) mentioned:

When many individual diagrams are aggregated to the level of cities and regions, these visualizations may provide geographers, for the first time, with truly dynamic maps of dynamic human processes. One might imagine them as twenty-first century "weather maps" of social processes.

Our research work produced first instantiations of these possibilities. In practice, most case studies led us to develop algorithms based on interactions with wireless networks or the web to detect presence, mobility and flows (Chapters 2, 4, 5, 6). The logs of these interactions considered as digital shadows or digital footprints were fed to tools to replay space-time activity, to study location-awareness or air travel. The techniques, methods and tools to analyse user-generated spatio-temporal data and uncover novel viewpoints on the presence and movements of people during their visit of a city and the understanding of the evolution of the attractiveness of the space (Chapter 6). The cross-analysis of the data over weeks and months allowed to see that each type of log was representing different tourist dynamics (Chapter 5). This end of the ephemeral calls for new approaches to privacy issues. In consequence, each case study treating quantitative logs provided an approach to preserving individuals privacy such as the use of explicit disclosure of data in case of a relevant event (Chapter 4), the analysis of publically available georeferenced photos (Chapter 5), and aggregated cellular network traffic data (Chapter 6). Finally, our taxi driver study (Chapter 3) also sets stage to the end of the timelessness considerations of human interactions with ubiquitous geoinformation. Indeed, we observed how a satellite navigation system does not perform the same service the first six months in the practices of an inexperienced taxi driver compared to a user with 20 year of knowledge of the city. Moreover, these users do not, over time, request the same granularity of geoinformation nor they do assess the quality of the information with the same experience of the technology and knowledge of the city.

Aspects of human-space relationships

With the developments in digital communications technologies the access to geoinformation became ubiquitous and interactive. Maps are generated "on-the-fly" to meet particular needs (e.g., web mapping services, in-car navigation, and on-demand mapping to mobile devices) with a tailored view of the world centered on the user's location, changing the relations of people with the space. We have seen that it alters the learning process of the environment and social relations (Chapters 2 and 3). We hypothesized that the reasons of the presence of digital footprints has relation to the space they are georeferenced to. In response we explored that hypothesis first with the detection of air travel as the context. Then we also highlighted this relation with the semantic description of the space that helps reveal features of a space (e.g. the spatial presence of ruins in Rome with Flickr photos; Chapter 5). Finally, in the fifth case study (Chapter 6) we defined indicators that compare the evolution of the attractiveness and popularity of points of interests from the relative density of digital footprints confirming the hypothesis.

Evidences of the ubiquitous computing of the present

At a more abstract research level, these contributions bring evidences for a "ubicomp of the present" as claimed by Greenfield (2006), Bell and Dourish (2006) and Rogers (2006); with a conscience of the ubiquitous of today, its potentials, and its human and social implications - taking the messiness of everyday life as a central theme – seamful instead of seamless. Indeed, this "ubicomp of the present" is a massive decentralized agglomeration of the devices, connectivity and electricity means, applications, services, data and interfaces, as well as material objects such as cables, antennas and satellite navigation systems and support surfaces such as mobile phones that have emerged in an almost anarchist fashion, without a recognized set of guiding principles. This conditioned the unconventional and real-world aspect of our case studies that took stage on a university campus and cities (i.e. New York City, Rome, Florence, Barcelona). We led our research to unbeaten territories where administrative procedures were inexistent. In this context, liability and privacy issues are the obvious subjects that necessitate constant clear descriptions of the motivations, goals, data sets and methods used. This process requested to develop skills to communicate the value of the analysis for the present and the future to stakeholders, local authorities, journalists and citizens.

7.3. Implications for future research

From our initial work on collaborative location-based games (Chapter 2), the application field of our research has come closer to urban issues. Next, we discuss the implications of the contributions of this thesis framing further research on the integration of ubiquitous technologies into people's everyday lives in the urban context.

From hard to soft infrastructures

As suggested by the contributions of this thesis, in contemporary urban environments, it may not only matter how good the hard infrastructure is, it is the software infrastructure that also affects how individuals experience it. Software infrastructures are not only about technology, they are also about interaction designs, about taking into account the wider context of organization, systems and people, and even business models, legal and political contexts, belief systems and social and cultural fabric. If we do not understand these aspects, we are prone to make the same mistakes as those originated by past visions that relied on the fascination around the hard infrastructures and reducing cities to systems (Jacobs, 1961).

In this thesis, we have analyzed the potential weakness of soft infrastructures, which are not free from the social technical gap. Uncertainty – granularity - in the sensed data plays a role in the gap. This opens all sorts of doors regarding sampling density, standardization, quality control, power, control, officiality of data, update frequency (freshness), discovery mechanisms, ontologies and so on. The problem is not only with user-contributed data: its accuracy has been one of the big "gremlins' often overlooked in Geography; just because data come from an official source and has official metadata does not mean that it is accurate or updated. In consequence, when these data are wrong or controversial the repercussions can be huge. The Geographic Information Systems (GIS) field has a long history of tackling it and has created standards such as the "National Standard for Spatial Data Accuracy" as part of the official Federal Geographic Data Committee (FGDC) metadata. While these standards worked for dealing with data accuracy in traditional GIS, are they sufficient or appropriate for the user-generated data we explored in this thesis?

One source of solution might come from the user-generated data themselves. OpenStreetMaps[23] has made a strong case for "crowdsourcing" creating more accurate and timely maps (if not more complete) than traditional GIS approaches. Is there potential in using crowdsourcing to make all geographic data more accurate and timely? For instance, in Clickworkers[24], the National Aeronautics and Space Administration (NASA) relies on human perception and common sense to identify craters on Mars. OpenStreetMaps has presented an approach for increasing the timeliness and relevance of geographic data, but the commercial data providers often fail in this approach, to the current exception of TomTom Map Share[25] that thrives in its users community to correct the geographic information. Further study on the sustainability of these solutions will be necessary.

However, even if the data become perfect and accurate, the digitization of the world thus far is coarse, leading to gaps and pixelation. As we fill in those gaps through models and assumptions we blur certain details, while artifacts of the process are categorized as anomalies. In geographic information systems, this gray area is referred to as "uncertainty" and is not often reflected in users representations such as maps. According to our approach, we should find ways of following the opposite strategy, providing seamful representation to users. Following our argumentation line, it seems that the improvement of the relationships between hard and soft infrastructures should come with engaging the actors. We see using visualization as one way to stretch the imagination of the users and engage them into action. Some promising contemporary projects of exploitation of these soft infrastructures aim at revealing in real-time the invisible urban activity (Ratti et al., 2006) and return this information back to the people, forming a feedback loop (Calabrese et al., 2008).

Replay the city

The presence of the soft infrastructure and its logging capabilities implies that we are at the end of the ephemeral; in some ways we

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[23] http://www.openstreetmap.org/
[24] http://clickworkers.arc.nasa.gov/
[25] http://www.tomtom.com/page/mapshare

have new means to replay the city. This potential to replay the city echoes very well with the recent interest of urban planners and designers in unconventional data sources[26]. Currently land use and space activity data are mainly collected through very traditional means with people paid to perform manual count. These non-longitudinal data limit the emergence of evidences from the statistical relations with variables (e.g. What is the effect of physical layout on movement? How do people use the space?). With the increasing availability of soft infrastructure the process of data collection is improved. For instance, it allows to better model time, space, and behavior as investigated in the domain of Geosimulation (Beneson and Torrens, 2004). In contrast, we are also ahead of conflicts to reveal or hide unwanted evidences, when new data can be used to the detriment of some stakeholders.

Nevertheless, the aim is to shift the urban design and planning practices from the speculative predictions and accommodation to more factual observations and improvements. Besides our work on urban attractiveness indicators, other research groups have been using a reality mining approach to derive specific characteristics of urban dynamics (Kostakos et al., 2008). A major challenge in this type of approaches is to draw a clear understanding of the boundaries and biases of the data. For instance not to confuse behaviors with endorsement, that can be considered as a limitation of our fifth case study (Chapter 6) which used the density of digital footprints as indicators of urban attractiveness. Therefore, future studies will need to rely on calibrations with ground truth information produced with proven techniques.

From data-driven urbanism to human/data-based urbanism

This ability to replay the city shows that there are opportunities for researchers to propose novel ways to describe the urban environment. However, there is a big assumption in seeing the world as consisting of bits of data that can be processed into information that then will naturally yield some value to people. It would lead to what we would call data-driven urbanism, as if urbanism could be driven by data. Indeed, the understanding of a

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[26] Insights from a presentation given by Noah Raford (Director of Space Syntax): http://liftlab.com/think/fabien/2008/06/02/technology-people-place-and-space/

city goes beyond logging machine states and events. In consequence, let us not confuse the development of novel maps from previously uncollectable and inaccessible data with the possibility to produce "intelligent maps" [27]. Our work precisely draws some critical considerations on the current state of the art. At this stage we are still trying to figure out: 1) What parts of reality the data reveal? 2. What we can do with them? 3. How to communicate them to people for acquiring information (still a far stretch from "intelligent").

Taken this caution into account, the application of our research approaches seem promising to gain knowledge on the presence and flows of human at a specific space (e.g. Lower Manhatan in New York) and with particular technologies (location-aware system in CatchBob! and satellite navigation system of taxi drivers in Barcelona) leading to an approach we would coin as "human/data-based urbanism". It could consist in the use of:

The qualitative analysis to inform the quantitative queries: This approach first focuses on people and their practices, without the assumption that something computational or data process is meant to fall out from that. This qualitative angle can then inform a quantitative analysis to generate more empirical evidences of a specific human behavior or pattern. A few approaches in that domain address this perspective. Williams et al (2008) for instance argue that our understanding of the city could benefit from a situated analysis of individual experiences within cities, rather than taking particular urban forms as a starting point for the study of urban experience.

The quantitative data mining to inform the qualitative enquiries: In that approach, the quantitative data help to reveal the emerging and abnormal behaviors, mainly raising questions. The qualitative angle then can help explaining phenomenon in situation. The qualitative approaches actually requests to ask the right questions to learn anything meaningful about a situation.

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[27] In response to Kazys Varnelis and Leah Meisterlin essay "The invisible city: Design in the age of intelligent maps":
http://liftlab.com/think/fabien/2008/07/19/the-data-driven-urban-computing/

An example of the latter could have been applied to the context of the impact of the New York City Waterfalls (Chapter 6). We used digital footprints to reveal the variations in spatial presence and abnormal patterns of temporal presence over the course of a 2 years period. In addition to this quantitative analysis we could have performed qualitative observation on the detected areas to reveal how the attractiveness evolves (e.g. Do people stay longer?).

This fosters the need for research and practitioners to develop a coherent understanding of the traces of the activity: both qualitative (e.g. audio and video recordings of action and interviews) and quantitative (e,g. logfiles). With significant data on actual use of the space, we can perform new types of "Post-Occupancy Evaluations" often overlooked in the practice of urban design and architecture (Brand, 1995). For example, Hill and Wilson (2008) propose multiple perspectives in analyzing the spatial usage patterns in a post-occupancy evaluation of wireless services in public buildings. It implies the collection of photo-essays, videos and in-depth interviews with users, and relating to this idea of making the invisible, visible. As a result, looking at usage patterns from various quantitative and qualitative perspectives, some analysis can be performed on how the variability of wi-fi maps onto the informal use of space enabled by the design of the space (see also Sevtsuk et al., 2007 for this approach). The objective of this methodology is not only to perform subsequent adaptations on the design object but also to reuse the lessons learned as input of other projects. However, the tools, metrics and interpretation methods are still, for a major part, to be developed.

Ethical issues and privacy concerns

Ubiquitous geoinformation are both immensely empowering (for the people and places able to construct and consume them) and potentially overpowering as institutional and state forces are able to better harness information with growing personal and spatial specificity. In consequence there are ethical and privacy implications to grapple with. In conjunction with people's own representation of traceability, there is a legitimate concern on the derive of research on geographically-anchored digital footprints presented in this thesis. Current debates crystallize around the issues of gathering data from people without their knowledge and the risk to reveal individuals from aggregated sensor data (Gutman and Stern, 2007).

We differentiate ourselves from the approaches that rely on the deployment of ad-hoc sensor infrastructures. First, our research innovates within EU directives[28] with on one hand anonymized, aggregated or publicly available data (Chapters 5 and 6), and on the other hand with the ability for the individual to opt out and refuse the transmission of private information (Chapter 4). Second, we apply the results to the context of cities services (e.g. tourism) and develop tools and techniques for the interests of citizens and visitors. Of course it implies revealing information that might not be of primary benefit of each individual who contributes to a census. Indeed, some of this information can challenge political decisions that were previously taken based on assumptions or limited survey data. For instance it might lead to a decrease in the offering of public transport in an unjustifiably well-connected neighborhood.

Therefore, our scientific contribution that provides an understanding of the potentials of digital footprints analysis, also contributes to the debate on ethical issues and privacy concerns. There are emerging initiatives on ethical guidelines for user experience in ubiquitous computing settings (Greenfield, 2008). This further proves the need for open discussions about the implications of these things considering a societal shift from a centralized "Big Brother" to distributed "bottom-up" surveillance (Batty 2003). Indeed, our work exemplifies the shift from large-scale top-down big brother thread on privacy issues to more local bottom-up little sister types of people monitoring, which makes the whole notion of opting out of technology adoption one of whether to opt out of society"

That being said, there have been numerous studies in the past that focused on "counting" people and measuring flows. It is interesting to note that it is not the first time that researchers and practitioners are looking at intimate part of city dwellers' lives. For example, the use of trash content analysis executed in Geodemographics (Harris et al., 2005, pp 231-232) seems to raise fewer concerns, although it

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[28] particularly the 2002 Directive of the European Parliament and Council on Privacy

can also be invasive. In other domains, there is an ever growing number of personalized records which are being collected, and at times disseminated in the databases and customer management systems of businesses, organizations, and government agencies that service modern living. In fact, these digital footprints have become inevitable in contemporary society and also necessary if we wish to enjoy many modern conveniences; we can no more be separated from it than we could be separated from the physical shadow cast by our body on a sunny day (Zook et al., 2004). The growth of our data shadows is an ambiguous process, with varying levels of individual concern and the voluntarily trading of privacy for convenience in many cases.

In summary, at the same time as ubiquitous geoinformation gives us new means to map and model human dynamics, it will also challenge current notions of privacy and make the object of study much more fragmented, dynamic, and chaotic. The challenge will be to appreciate and use the complexity and richness of ubiquitous geofinformation without crystallizing into authoritarian structures.

7.4. Concluding remarks

The emergence of ubiquitous geoinformation, as explored in this thesis, coupled with the considerable progress in the field of GIS, currently places us on the verge of a revolution in human time-space activity research (Shoval, 2007). Our work contributes to this evolution in creating a clear cut with respect to the existing remote sensing, arguing that human sensing enables to sense people directly, in contrast to remote sensing that applies more to the domain of physical geography. People-centric sensing adds a new layer of data to our digital earth (Goodchild, 2007) allowing us to understand it better through time and space. This complex layer is both challenging our capacity to make sense of the data collected and the people's willingness (or unwillingness) to act as data collectors.

Research in that domain draws together researchers from a broad spectrum of academic communities, for example, from geography, urban (urban studies, urban planning) and technical ones (computer science, software design, human-computer interaction etc.). Moreover, it focuses attention on the opportunities and problems of such ubiquitous computing. Currently, "Urban Informatics" is not a research field but rather a set of intersecting practices and broader disciplines swirling around those practices. It focuses not so much on the technology, but rather on its implications for (human) city life: *Informatics with its implied reference to information systems and information studies, slightly shifts the attention away from the hardware and more towards the softer aspects of information exchange, communication and interaction, social networks and human knowledge* (Foth, 2008).

We understand this intersection with three main tendencies: understanding urban dynamics, understanding the integration of ubiquitous technologies in urban life, and designing technologies for people in the city. Others defined it as "*the integration of computing, sensing, and actuation technologies in everyday urban settings and lifestyles*" (Kindberg et al., 2007) or "*the collection, classification, storage, retrieval, and dissemination of recorded knowledge of, relating to, characteristic of, or constituting a city*" (Foth, 2008).

A majority of the research done in one or several of these elements of "Urban Informatics" has been driven by a utilitarian perspective, that models the city as a system and then aims at improving its efficiency. The background work in that domain partly explains the lack of consideration of human and social realities. Without blaming computer and information scientists, engineers, architects, or urban designers, none of them are necessarily trained in assessing the implications of their interventions. Only recently the techno-deterministic approach has been challenged through the influence of designers (Greenfield and Shepard, 2008), social scientists (Anne Galloway, 2008), and geographers (Hubbard 2006; Crang and Graham (2007)). Their influence generates the emergence of a new language that computer scientists and experts of the built space can integrate in their research and work, forging transdisciplinary practices. In consequence, it is noticeable that now social considerations go beyond privacy issues and touches the domains of the user experience, the impact of the research (e.g. positive change of practices) and the design for its appropriation (e.g. how to integrate into citizen daily life or a city administrative decision process). This language could also influence another layer of practitioners: the one mostly concerned with the problems of those who rule space or those who want to change policies (e.g. associations, street corner lobbies, public institutions, think tanks). These people are more concerned by change (social change) and the use of technology to go beyond current practices.

Therefore, beyond a utilitarian perspective, we have to consider the promises and hopes around these future cities and their informational membranes. If researchers and practitioners offer citizen better awareness of the city dynamics and power to influence the city evolution, this does not mean they will accept the gift. Indeed, taking the example of citizen-science (Paulos et al., 2008) and volunteer-generated information (Goodchild, 2007), citizens might just not be interested in the collection of data, and the opportunity might increase the divide between the people who are able to participate and those who are not or do not.

Throughout our work, we have shown that for every enabling technology we embrace, we should require ourselves to consider their implications and the strategies individuals and designers develop to appropriate them. Indeed, technological force and social counter-force technology pushers too often fail to recognize the difference between solving a problem and contributing to the health of society (Talbott, 2000). When failing to notice the messiness of everyday life, the design of a technical device or procedure can solve problem X while worsening an underlying condition much more serious than X.