IMPROVING URBAN SECURITY THROUGH GREEN ENVIRONMENTAL DESIGN

NEW ENERGY FOR URBAN SECURITY

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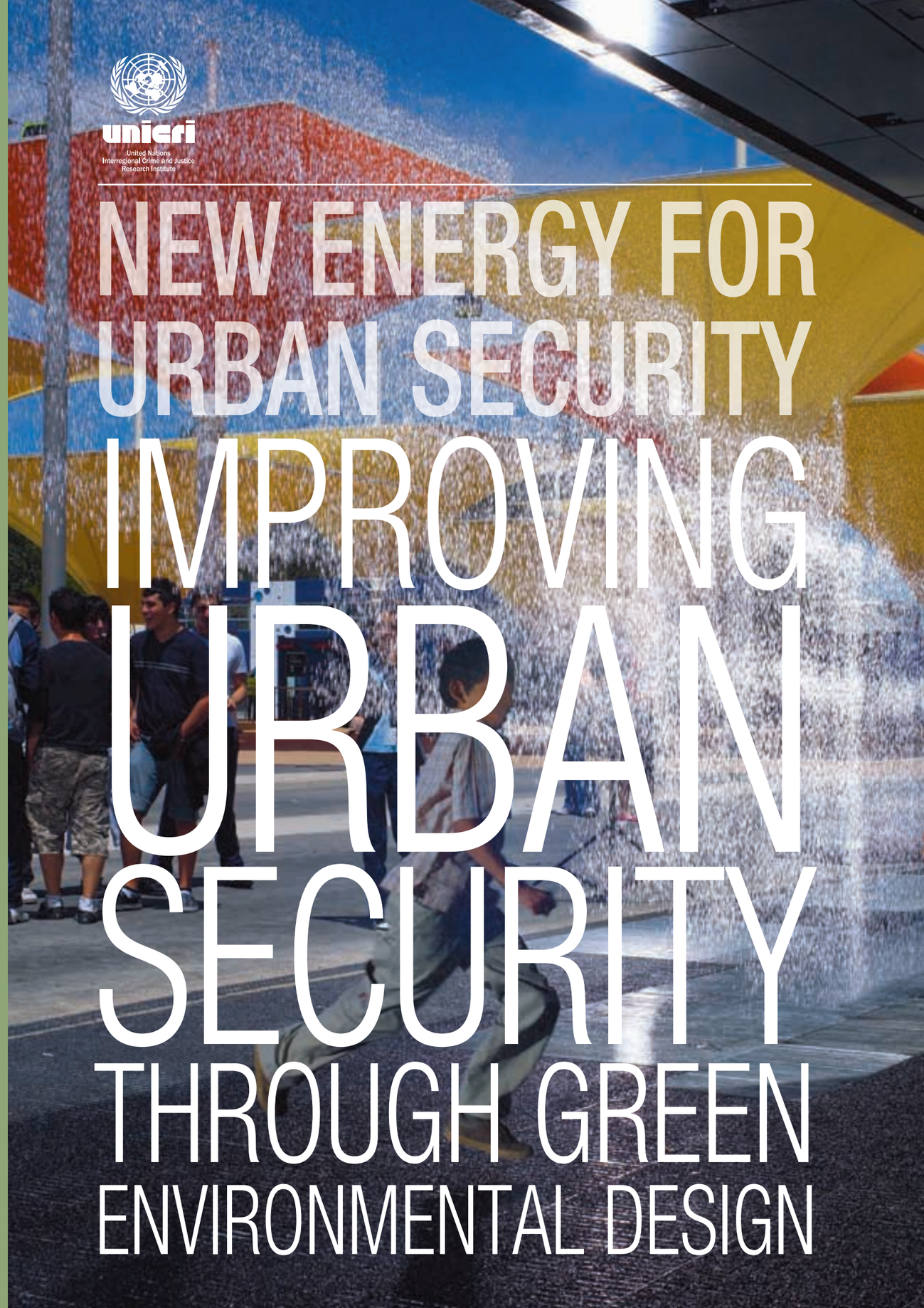


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senseable city lab
MIT Massachusetts Institute of Technology

Team:

MIT SENSEABLE City Lab

Prof. Carlo Ratti
Head of the Lab

Nashid Nabian
Project Leader

Giovanni de Niederhausern
Filipa Carvalho
Jennifer Young

UNICRI
Security Governance
Counter Terrorism
Laboratory

Francesco Cappè
Head of the Lab

Alberto Contaretti
Deputy Head of Office

Nicola Filizola
Project Leader

Introduction

The unprecedented urbanization of our world comes with various challenges to the goals of properly designing and efficiently managing our cities. These goals and related issues expand over a vast intellectual landscape, crossing the conventional boundaries that delineate the extent of intervention by various disciplines. The first decade of the 21st century has highlighted the importance of designing cities that provide the physical, virtual, social, economic, and cultural infrastructure for maintaining a standard of living that allows inhabitants to perceive their environment as a desirable, safe, and secure place to live and work.

Hence, a multi-disciplinary approach is necessary to both identify the challenges of urban life and arrive at solutions to its pressing concerns. Some of the issues complicating the achievement of this goal are the crisis of the fuel-based energy paradigm, global warming and its immanent environmental impact, the carbon footprint of urban living, urban sprawl, mobility and traffic management, pollution, waste management. Then there are the challenges of mediating conflicting social, cultural, political, and economical interests: poverty and the socio-economic divide; and most importantly, safety and security, both in relation to preventing crime and reducing the fear of crime.

A core action of the Security Governance/Counter-terrorism Laboratory (the Lab) of the United Nations Interregional Crime and Justice Research Institute (UNICRI) is to support the policymakers to design and implement effective policies in the security field. In the specific area of urban security, the UNICRI Lab established a partnership with the SENSEable City Lab of the Massachusetts Institute of Technology (MIT) to investigate the impact that a green urban design and eco-sustainable urban solutions have on the security of modern cities and the perception of security of contemporary citizens.

As a first result of this collaboration, this report intends to provide the urban policy-makers with a series of concrete suggestions to design effective environmental policies and take concrete measures that have an impact on the urban security and its perception among the citizens. The theoretical framework provided in this work is a revision of the current Crime Prevention through Environmental Design (CPTED).

This report intends to be a manual for a green and digitally enhanced environmental design that addresses the concerns of cities. It also intends to provide an index of strategies useful in green, sustainable, and digitally enhanced urban design that have a direct or indirect impact on enhancing the image of the city as a safe and secure environment. Each section of the report identifies a particular urban challenge that needs to be addressed through environmental design; provides a set of green, digitally enhanced guidelines for arriving at solutions to the identified challenge; and concludes with actual or visionary projects that at least partially deploy the proposed guidelines, demonstrating their prospective effectiveness.

The vision employed in addressing these challenges is supported by projects developed at MIT SENSEable City Lab, or proposals that build on the developments resulting from previous projects.The report concludes by exploring the potential application of the proposed program to crime prevention and the enhancement of the perception of safety in urban areas, which is identified as the third-generation of CPTED.

Finally, we gratefully acknowledge the generous support of the Compagnia di San Paolo, which made this work possible.

1

The greater context of green and sustainable environmental design as a discipline

An index of the contemporary challenges of urban living

1.1

Addressing the energy crisis

Urban-related energy consumption is mostly concentrated in two areas: mobility and conditioning the urban spaces in terms of lighting and thermoception. Yet, urban energy consumption currently relies heavily on finite natural energy resources. As a response to the energy crisis, three closely connected sets of solutions are proposed:

/1 Deploying alternative, renewable, environmentally lower-impact energy resources,

/2 Optimizing energy consumption in terms of urban mobility,

/3 Optimizing energy consumption in terms of conditioning the city's interior spaces.

In terms of alternative approaches to energy production, harvesting natural energy such as wind and solar power is a potential solution. Natural energy harvesting can be deployed in centralized sites, or locally within the erected structures of urban areas. Roofs and facades are possible sites for these new, localized infrastructures of energy production: solar panels and small-scale wind turbines can be integrated into a building's architecture as roof or facade tiling systems.

For each and every substantial structure in the city, including buildings and furniture, localized energy-harvesting mechanisms can be embedded to provide the required energy or augment the fuel-based energy mechanism. In terms of more centralized urban landscapes, due to the fact that natural energy harvesting is not a polluting industrial activity, wind or solar farms can be integrated into the infrastructure of urban parks and street networks. Depending on the morphology of the city, between 50 and 70 percent of the urban real estate is dedicated to infrastructures of mobility. If you add rooftops, urban facades, and parks to this large amount, you have vast surfaces within the city that can be considered as possible sites for harvesting natural energy.

Another possibility for generating alternative energy for urban consumption is bio-fuel. Algae is the most promising source of alternative, bio-based fuel production. Not only is the carbon-based, bio-mass product of harvested algae a reliable source of energy, a by-product of algae farming is highly efficient carbon sequestering that can alleviate the carbon footprint of urban life. Just like wind and solar farms, algae farms can easily be integrated into both the urban fabric and the individual structures of the city.

When it comes to urban mobility, different ways of optimizing energy consumption must be considered. Relegating real estate investment to developing dense urban cores instead of creating more urban sprawl will result in a decreased demand for long-distance urban mobility. Designing multi-use zones for living, working, shopping, and entertainment within these urban cores eliminates the need for daily trips between single-function zones. Furthermore, enhancing the infrastructure of public transportation, providing incentives to increase its use by the public, and discouraging private transportation are other possible techniques for optimizing urban mobility. For example, situated technologies can be deployed to create smart, urban-scale tolling mechanisms that effectively penalize users of private transportation,

Alternative, green modes of transportation should be enhanced and their use should be encouraged. Smart vehicles with hybrid modes of energy consumption and/or electric vehicles can replace the conventional fuel-based modes of urban vehicular transportation. Moreover, designing pedestrian-friendly cities will encourage citizens to navigate the city on foot instead of relying on energy-consuming modes of transportation. Properly designed infrastructures for biking should be provided and their use encouraged by capitalizing on digitally mediated social networks to incentivize the public to change their mobility behaviors. The combination of digital social networks and situated technologies can also promote community-based ride sharing to circulate both individuals and goods within the city.

Another major set of solutions to the challenges of urban mobility deploy situated technologies to provide context-sensitive, real-time information about traffic that allows inhabitants to make informed mobility decisions based on the most current urban dynamics. Platforms for delivering real-time information can impact the decision making of their users at two levels. On one hand, they provide a realistic view of traffic congestion, the most efficient route between origin and destination, and information about public transport that allows users to plan their trips. On the other hand, this type of information can impact the user's individual mobility decisions, highlighting how individual decisions and the global conditions of urban transportation can negotiate and inform each other to establish a more efficient and environmentally lower-impact paradigm of mobility.

In terms of optimizing energy consumption of interior spaces, instead of the conventional, holistic approach of conditioning the entire space, one can integrate situated technologies when erecting interior spaces. These technologies would provide the occupants with limited, personalized comfort bubbles that follow them within the space, and at any given time provide the desired level of lighting and temperature for a particular zone whose occupancy is identified through embedded sensing mechanisms, leaving the un-occupied areas of the interior un-conditioned, and hence optimizing the energy consumption.

While the above-mentioned design strategy looks at energy consumption in interior conditioning, another set of techniques can respond to the need for minimizing the energy consumption of an entire building. Smart cladding systems, and building materials enhanced with digital technology that function as context-aware cybernetic mechanisms, can be used in the construction of substantial structures to regulate heat gain and loss, depending on the season. For example, kinetic facades and shading devices can enhance heat gain and minimize heat loss during the winter. Using natural techniques for air ventilation and implementing digitally enhanced wind catchers can also alleviate the energy consumption of air ventilation during hot summers.

1.2
Addressing urban pollution

The conventional urban lifestyle has a detrimental impact on the environment that includes air pollution, water pollution, soil pollution, and the generation of garbage and urban waste. Using fuel-based energy for urban mobility and interior conditioning bears the most responsibility for polluting the air. The previous section's discussion of addressing the energy crisis by using alternative energy and optimizing energy consumption can alleviate this situation. Purifying the air through integrated infrastructures such as urban greenscapes is another path to take. Photosynthesis is the natural mechanism for carbon-sequestering—eliminating CO2. Particular types of vegetation are also capable of capturing other toxic gases. To this effect, deploying green landscapes and green facades and roofs will capitalize on real estate already provided within the fabric of the city for natural air purification mechanisms.

Water waste is next on the list when it comes to the polluting impact of urban areas. Efficient management of sewage both locally, as in integrated septic tanks, and centrally, as in efficient sewage collection networks, needs to be prioritized in designing cities and the substantial structures within them. Furthermore, two different classes of water management should be incorporated both in urban infrastructures and urban structures. Grey water, the water from showers and kitchen sinks, can be treated where it is produced to be recycled for uses that do not require intensive treatments, such as watering the on-site vegetation. The production of grey water can also be reduced by implementing digitally enhanced, context-sensitive plumbing that minimizes the water usage. Different mechanisms at the architectural or urban scale can also collect water from rain or snow to be used on site, or to be managed centrally as a secondary source of urban water. To this effect, all the horizontal surfaces within

urban areas, including streetscapes and roofscapes, can be possible sites of water collection.

1.3
Recycling and mimizing urban waste, and waste management

Promoting a culture of recycling both as an actual mode of operation and a cultural image of urban living can decrease urban waste. This is important to establishing a sense of ownership and belonging that contributes to the urbanite's self-image as a member of a collective social entity. To this effect, cyber structures of social networking can provide various opportunities to incentivize recycling between their members. Additionally, situated technologies can be deployed in the waste management and urban removal chain to secure the maximum efficiency of waste treatment and waste recycling on a large-scale and centralized mode.

1.4
Reprogramming the physical space and material-based consumption: online services and cyber functionality

Another set of multi-disciplinary interventions can target the culture characterized by the production and consumption of material products. Part of the appeal of urban living is the prospect of a particular social status that an individual achieves by acquiring material resources and amenities. The conventional cultural image of urban prosperity is linked to the idea of possession: possessing property, books, gadgets, furniture, etc. The more the population demands human artifacts the more is produced, and more artifacts means more urban waste when they are discarded.

We demand goods partly because we actually need them, and partially because possessing them creates an image of prosperity. Promoting certain aspects of digital culture allows for decreasing the demand for both types of goods. On one hand, networked modes of living and cyber culture have allowed for a paradigmatic shift from possession to access. In the pre-cybernetic era, what one had would define him as a social being. In a cybernetically enhanced world, what we have access to will define us. We do not have to possess cars as long as we can access a shared one with an online service that allows us to reserve it when and where we need it. This covers the class of goods and products that we need, demand, and acquire out of necessity.

For the other type, things that we acquire because of their appeal, digital or virtual products can substitute for their physical counterparts. For example, an iPhone app can replace an accessory for the consumer base that is interested in being identified as a member of a certain social class. Or, another iPhone app can transform the phone to a GPS navigation system for the car. Hence, there would be no need to acquire another device for a certain service if a device one already owns could be reprogrammed to do the job.

Moreover, many urban-related services that once required a physical infrastructure are now being offered on online platforms—take banking as an example. This minimizes the need for service providers or physical spaces of operation. The less physical space is needed, the less physical space is erected, minimizing the negative impact of urban construction. On the other hand, if the requirements of a given operation are less substantial, then the very same physical space can be used for different, simultaneous activities, given the right technological platform. For example, a publicly shared space can be used by a student to access the digital library of his college, while a professional uses it as a work space to communicate with his colleagues via the audio-visual function on his personal computing device. This demands that network services cover whole cities, transforming all the existing physical spaces to multi-functional spaces.

Taking this into consideration, some services could migrate to cyber platforms: e-government, e-finance, and e-shopping are among many of the most promising areas for this type of investment and speculation. Once many urban services are relegated to non-substantial or less-substantial modes of operation, the physical spaces previously dedicated to governmental institutions, shopping, or banking would need to be re-programmed. This reprogramming is a possible site of intervention by spatial practitioners, mainly urban designers and architects.

To conclude, this sub-section looks at two closely connected ideas: first, if urban services totally or partially migrate to online platforms, the physical spaces they formerly occupied can be partially or totally reprogrammed for socio-cultural activities that require face-to-face interaction between the provider and recipient of a service. This would impact citizens' perception of their standard of living, while minimizing the need for physical development by adding a digitally mediated depth to our cities. The word "reprogramming" the space best explains this half of the proposed package in that it clarifies that we do not propose fully replacing the physical urban structures with cyber-space, but that the space can be rearranged and digitally enhanced to acquire a performative depth that allows for more efficient use. Second, migrating the sense of ownership from possessing material products to having access to cyber-services can have an impact on the carbon footprint of urban living on one hand and poverty on the other: the latter impact has a direct impact on urban security. What we define as petty crimes are crimes related to generating wealth for the acquisition of goods and services necessary for urban living. These are frequently committed by those who cannot afford the urban

lifestyle without resorting to criminal behavior. Moving some of the services and products to cyber platforms will reduce the cost of having access to them, which will likely eliminate the incentive to commit crime out of financial necessity.

1.5
Addressing urban poverty

One of the most pressing issues for today's metropolitan areas is that of urban poverty and the economic divide. Social housing and employment are two potential areas where green environmental design could intervene. Embedded technologies could efficiently monitor disadvantaged communities to prevent crime, while low-cost urban interventions could improve the streetscape of less advantaged neighborhoods. Cyber infrastructures of social networking could also be deployed to create a sense of community and belonging for the members of these social groups, while providing a portal to inform institutions and governmental or non-governmental agencies about the pressing concerns of the community.

If some of the necessities of daily living are relegated to cyber platforms, the required domestic space for disadvantaged families could be minimized, while more communal and less private activities could happen in public and semi-public spaces. For example, if the culture of car-sharing is widely promoted, then the space allocated to parking the family car could be omitted from architectural scheme of the domestic space. Instead, publicly available parking lots all around the city should be allocated for shared cars to be parked, available for booking via online services, and picked up at these locations around the city. If playgrounds, gardens, and parks are incorporated into the design of residential neighborhoods, this could compensate for the small size of a private home by providing space for activities such as children's play, adults' socializing, or exercise. Online services could augment the function of a neighborhood's public spaces by providing a cyber platform for the community to plan events, manage the booking and activity schedule of these spaces, communicate about their concerns and plans, etc,

In this regard, green environmental design can be applied to arrive at minimalist architectural schemes for small or extra-small housing units. At the same time, embedded technologies can convert the inert, fixed architectural spaces to multi-use, responsive environments that transform in real-time based on what they sense about the desires, needs, and preferences of their occupants, or their direct input. An architecturally responsive domestic unit can transform to a kitchen at one time, while maintaining the potential to change back to a living space.

Employment is another possible site for intervention by green environmental design. Cyber services can enhance small, family-based practices and self-employment. Different low-cost mobile services can be provided to small-scale businesses whose owners are not particularly tech-savvy, but are capable of adopting digital technology in their existing or nascent businesses to connect to their consumer base and regulate transactions with their target market.

The above-mentioned design-based interventions are not limited to urban poverty in under-developed, developing, or developed urban areas, but can also be used in post-disaster, post-conflict situations. A section in the text that follows will elaborate more on relationship between CPTED and post-conflict urban conditions.

1.6
Mediating conflicting interests in urban settings

Urban areas, particularly their public spaces, are potential sites of conflict between various groups and individuals with differing social, cultural, political, and economic interests. However, they can also be sites of mediation between differing parties, particularly in post-conflict situations. Deploying situated technologies can transform the publicly shared spaces from zones of fear and conflict to interactive fields that create a sense of community, belonging, and mutual social interest.

Different digital augmentation techniques can be used to make public spaces more interactive. Publicly shared architectural surfaces can transform to portals that deliver real-time information to denizens. They can also be used as digital boards for people to record their thoughts and concerns about their city. Effective and occupant-friendly surveillance can discourage crime while enhancing the perception of security in publicly shared urban areas. Integrated green spaces can transform abandoned urban zones to oases of calm and peace, rest and entertainment for communities. Low-cost and lightweight structures can enable these spaces to serve as temporary sites for various social activities, such as performances, markets for locally produced goods, low-cost classes, etc.

Multi-functional urban furniture can provide various services to different social groups. A multi-function bus stop can serve as an interactive portal of information for commuters while offering shelter to the homeless during night. For example, the bus stop's bench might transform to a small shelter when it detects that the temperature is going below a certain point. Additionally, providing platforms for digital graffiti in public spaces will provide an interface for denizens to leave a non-substantial imprint that distances itself from conventional modes of urban resistance and graffiti, which fall under the

category of vandalism.

Substantializing cyber social networks within public spaces with digital constructs and interactive artifacts offers the potential for the sustainable regulation of social conflict. As contemporary urbanites, we simultaneously live in two different, closely connected spheres: the hands-on material sphere, and the info-sphere populated by digitized annotations. Interfaces are points of interaction between these two systems, points that can be defined as information touchdowns for accessing and interacting with digitally encoded messages. This information can be retrieved based on the temporal, spatial, and contextual specificities of the users, as well as their actively specified inputs. These interfaces are facilitated by embedded sensors and actuators: the sensors sense the context, while actuators respond to the change in the context based on what is sensed.

Surface-as-interface is the domain in which bits and atoms are combined and the virtual and physical are married, creating a hybrid condition out of the dynamic nature of information and the intrinsically static character of architectures that are erected as substantial structures. Whereas in the realm of desktop or mobile computing, information retrieval happens through mediators such as computers and handheld devices, thinking of architectural surfaces as sites for interacting with information allows for eliminating the mediators, transforming the act of interfacing with the info-sphere to an intrinsic part of experiencing the city. Different techniques—from simple projections to embedded digital displays, to augmenting building materials with computation capabilities that transform them to low-resolution displays—can be used to transform architectural spaces to cradles of real-time, context-sensitive information.

Shared spaces are powerful tools for addressing the voices of the many. In recent years, social opposition and resistance have frequently turned violent in the streets. In part, this is because the opposing parties do not have the proper interfaces to voice their concerns. Digital surfaces in public spaces could remedy this problem by serving as platforms for voicing community concerns, either through digital graffiti or street slogan writing. Gene Sharp provides a comprehensive theory of non-violent resistance and conflict-free social movements geared towards establishing a liberal democracy.[1] Among the 176 methods of non-violent civic action, a considerable portion is dedicated to formal statements; the communication of viewpoints, ideals, and demands with a wider audience; group representations and symbolic acts; and psychological, physical, and social interventions.

All of these civic actions need proper interfaces to manifest, and digitally augmented public spaces are fruitful potential venues for such actions: a student who set a garbage can on fire to show his anger about the passage of a certain law in the parliament can now use the digitally augmented architectural surface to voice his concerns. Digital urban screens controlled by citizens can be an addition to other peaceful/conflict-free demonstrations and civic opposition. An interactive/responsive architecture that acts as a facilitator or mediator of social interaction can also transform the space to a creative venue. Installing interactive art within public spaces transforms these spaces to more relaxed, eventful, or playful zones of social interaction, and that can have a direct impact on the perception of safety and security.

1.7

Supporting informed, efficient urban management using situated technologies

Cities are becoming more complex in their physical and virtual dynamics. To efficiently manage urban processes, officials need to have access to real-time information about how the cities and their inhabitants operate. Situated technologies allow distributed sensor networks to collect information about different processes of urban life via customized networks, such as environmental monitoring, or networks of smart tags that sense the modes of circulation of a particular class of materials and goods within the city. A different class of urban informatics is retrieved from already the operational service-providing networks that augment the city, collecting information about how they are used. This by-product, the collected repository of data pertaining to the usage of urban networks, can be accessed to retrieve valuable information about how a city operates and how its citizens behave. A third class of information is that which is willfully shared by citizens, particularly on social networking sites or cyber platforms for user-generated content. All three classes of urban informatics can be combined and their data aggregated to provide a holistic view of what is happening in the city, to identify certain patterns of risks and opportunities, and to decode the somewhat convoluted phenomena that we define as urban living.

On one hand, officials can access this information and factor it into high-level managerial decisions about the city. On the other hand, it can be fed back to citizens to give them a holistic view of how their city operates and of the global impact of their individual decisions, encouraging them to act more responsibly. These types of networks allow for a new form of urbanism that we define as real-time urbanism, one that is democratic and sustainable in its very nature due to the fact that the hidden processes of urban life become transparent to all acting and benefiting parties. This idea of transparent urban dynamics can also have a direct impact on the citizens' perception of safety.

Situated technologies can also be utilized to create city-wide, community-based, collaborative, and grassroots crime reporting mechanisms, where citizens themselves contribute to a knowledgebase about the safety and security of their city. Imagine a platform where citizens can stream what they detect as criminal behavior or safety concerns in real-time, via their cell phones. This information can be geo-tagged, aggregated, and represented on an online map that others can navigate to check how safe a particular part of the city is. Such a platform can be utilized as a tool to gauge the effectiveness of crime prevention and urban security policies.[2] It is worth emphasizing that aside from community-based, collaborative mechanisms, utilizing urban sensing mechanisms allows for seamless monitoring of space, which has an impact both on crime prevention and the perception of security.

On a more global scale, a wiki-like, urban information-sharing platform designed with a multi-disciplinary approach provides a portal for both the officials and citizens of various cities to share with the global community their concerns, their failed and successful interventions, and green environmental modifications. Over time, this type of platform becomes a work-in-progress manual for designing and managing a sustainable city for a green, sustainable citizenship.

1.8
The literally green city

One of the appeals of living in nature is the physical connection to green landscapes that is partially or completely obliterated from urban life. A prominent typology of green environmental design strategies focuses on integrating natural or artificial greenscapes in urban design. This allows for the integration of two major disciplines of spatial practices: urbanism and landscape design, or what academic circles have termed "landscape urbanism" or ecological urbanism." Aside from integrating vegetation in the conventional sites of streetscapes, public parks, and botanical gardens, green environmental design strategies can focus on artificial nature. Artificial nature belongs to the ongoing research on living walls, bio-walls, green facades, and vertical gardens that integrate natural systems into building components, particularly thresholds, that function as suitable sites for urban agriculture, gardening, or artistic intervention, while reducing the overall temperature of the building and making good use of available vertical surface areas.

Once such natural systems are deployed to vertical architectural surfaces, irrigation of the medium in which the vegetation is grown becomes more efficient, since the circulating water on a vertical wall is less likely to evaporate than in horizontal gardens, making such practices more ecological for arid areas. Green walls can also enhance the functionality of a building's HVAC (Heating, Ventilation, and Air Conditioning) to help with air filtration. Additionally, if mass-produced and deployed in large quantities, artificial nature has the potential to fundamentally transform our cities to more ecologically efficient constructed landscapes, decreasing the carbon footprint of urban living by optimizing indoor air filtration. Furthermore, its deployment in erecting substantial structures comes with a certain appeal to the urban naturalist, who can now recombine his desire to explore the possibilities of urban life with his yearning to maintain a certain proximity to nature. One can speculate on the not-so-far-off prospect of cities that function as living bio-organisms, with every imaginable surface breathing and letting inhabitants breathe in a technologically enhanced symbiosis between the natural and the artificial.

To this effect, green environmental design practices examine ways to implement technological constructs that integrate artificial nature with architectural systems. Since urban greenscapes can influence how the space is perceived by the inhabitants, an additional benefit is that they promise to make the streetscape more welcoming to those who navigate the city. A large part of making a streetscape safe and welcoming is to make it pedestrian-oriented, and the incorporation of greenscapes is integral to establishing the pedestrian nature of the streets.

1.9
Promoting interactive architectures and individuated spatial responses

Norbert Wiener's invention of the field of cybernetics had the underlying goals of expanding human control over his/her environment via interfaces with sophisticated electronics, and of combining man and electronics by thinking of computer technology as a means of extending human capabilities based on what Wiener defined as the "feedback principle." The feedback principle is when a system changes its course of action and mode of operation in response to the current context in which it performs, including the desire of the human agent controlling its operation.

Following Wiener's conceptualization of using computer technology and electronic interfaces to expand human capabilities, Gordon Pask proposed that architecture itself could become a sophisticated electronic interface. In this vision, architects might conceive of digitally augmented spatial solutions as cybernetic systems that accommodate the idea of interaction in their abilities to extract contextual information, acknowledging their inhabitants' desires and needs, and adopting behavioral patterns based on what they learn, hence soliciting human control over a technologically enhanced habitat.

Cedric Price's proposal for the Fun Palace was one of the first incidents of conceptualizing architecture as a cybernetic system, incorporating Wiener's feedback principle as a driving force for architectural performance that factors in the extended human capabilities to control his or her environment. The vision of architectures capable of soliciting their inhabitants' control over the production and consumption of space also prevailed in Yona Friedman's 1958 manifesto for Mobile Architecture. He proposed a loose framework within which the buildings would have the capacity to adapt and conform to the lifestyle and behavior of the inhabitants, as well as to their changing expectations of their living environment. To this effect, the space became an interface via which the inhabitants could realize their desires and regulate their needs.

Once physical spaces are transformed to context-aware, decision-making entities by deploying digital technologies and computational algorithms, their inhabitants can be incorporated as entities with transient desires, needs and preferences; as hyper-individualized "users" (as the term is employed in the user-interface and interactive-design disciplines) instead of pre-defined, generic "inhabitants." Once a digitally enhanced environment or artifact can be programmed to acknowledge its inhabitants' input or specificities of their behavior, inhabitants are then transformed to identifiable users, each deserving specific treatment from the space they inhabit. A user-subject is a hyper-individualized inhabitant as a result of her desires being constantly solicited by new technologies, and an interactive space respects the specificities of, and offers a customized experience for, each user.

In applying digitally enhanced, green environmental design solutions, the limitations, constraints and tendency toward standardization in the physical world are overcome through the recognition of a variegated public. This allows for the exploration of the possibility of hyper-customizing the spatial experience that digitally enhanced architectures and artifacts can offer. Furthermore, architecture that functions as a cybernetic mechanism capable of offering an individuated experience allows for extending the sphere of influence of their users. An inhabitant who recognizes that his needs and desires are properly incorporated into how his space performs feels more at ease in how he uses the space and occupies it. This enhances the image of space as desirable, safe, and secure.

1.10
Urban safety and security

There is no doubt about the impact of environmental design strategies on improving the security of urban areas. In fact, a particular class of environmental design practices focuses on crime prevention and reducing the fear of crime, called CPTED (Crime Prevention Through Environmental Design). In the section that follows, we will provide an extensive overview of CPTED in its first and second generation of theory and praxis. Using all the above-mentioned subcategories of green, digitally enhanced, environmental design methodologies, we will offer a new vision for a third generation of CPTED through minimum-impact, sustainable, environmental design strategies that use situated, green technologies. The proposed third-generation CPTED is also focused on reducing the fear of crime and enhancing the perception of security for urbanites.

To achieve the above-mentioned goal, four different dimensions of crime should be studied and addressed:

/1 The law, which is the set of socially agreed-upon criteria about what is considered a crime; the ramifications of committing a crime; the legal possibilities for compensating the victims of a crime, both from the governmental institutions and the offenders; and finally, the range of responsibilities and constraints of socio-political institutions and individuals fighting crime;

/2 The offender who commits the crime should be informed about the ramifications of his actions, discouraged from acting upon any future criminal intentions, and be confronted if he does;

/3 The victim of the crime should be protected, taken care of, encouraged to take safety measures to prevent being targeted again, and report it if he or she is subjected to a criminal act;

/4 The location where a criminal action [potentially] takes place, which should discourage the offender and protect the target, while positively impacting the residents' fear of crime.

Taking into consideration the above-mentioned four dimensions of crime and how each of them should be dealt with, environmental design strategies focus on different practices. Virtual platforms that can be accessible via different information delivery portals should provide institutionally mediated information about the law to the public. The very same cyber platforms can also capitalize on a user-generated knowledge base and public collaboration in refining the law and the agreed-upon code of conduct by providing cyber forums and discussion platforms.

Institutionally deployed urban surveillance mechanisms would enhance the visibility of urban areas, allowing officials to keep track of how safe various publicly shared spaces are. Additional cyber infrastructures that encourage the citizens to participate in reporting crime when they are a victim or an observer is another possible intervention for those who contemplate the impact of environmental design on crime prevention in cities. These citizen reporters can be provided

with an easy-to-use platform for streaming what they consider a criminal act in real-time from their handheld devices, using the wireless service of the city. The information collected from institutionalized surveillance mechanisms and grassroots, collaborative crime reporting can then be aggregated in centralized data management mechanisms and fed back to the public and law enforcement institutions. This information will help law enforcement agents to act in real-time, while providing useful information that makes the dynamic of the city more transparent so that the public may decide which zones are potentially dangerous and should be avoided. City officials should capitalize on the potential of social networking platforms and their logic of operation to engage in the public in integrated crime prevention systems so that they actually engage in reporting information and using the platform that provides information about crime.

The strategies discussed in previous sections can improve the living standards of city inhabitants, particularly in low-income urban areas. Physical and virtual measures of visibility such as surveillance, good street lighting, and enabling the public to report crime to a central server or those in their vicinity will discourage crime and provide some level of security to those who feel anxious about the risks of urban life. Most importantly, when the dynamics of urban areas become visible and transparent through digitally enhanced urban informatics, and when a particular class of social conflicts that can result in criminal behavior is mediated via digitally enhanced constructs; when the publicly shared spaces of the city are enhanced through design strategies and become more user-friendly; when the spatial quality and use of leftover spaces of the city is redesigned and refined; when cities become mixed-use and more densely developed so that they are operational 24/7 and never left unoccupied; the mental image of the city is improved for its citizens, and public zones transform to possible sites of interaction with other members of the public instead of dangerous zones of crime and conflict. Having provided an overview of the general field of practical and theoretical relevance when it comes to green, sustainable urban design, the second and third part of this report is dedicated to a more focused examination of how urban safety and security can be addressed through green environmental design.

Notes:

/ 1 Gene Sharp, The Politics of Non-violent Action (Boston: P. Sargent, c1973).

/2 These platforms have already been deployed in various cities. For example, the Las Vegas Metro Police Department provides an online platform called the Crime View Community (http://www.lvmpd.com/crimeviewcommunity/wizard.asp) that allows the users to navigate interactive maps with geo-tagged reports of crime incidence based on the location, type, and time of crime as search criteria. http://www.neighborhoodscout.com and http://www.crimereports.com/ are other examples of online platforms that provide similar services.

2

First, second and third-generation CPTED

An introduction to the general field of practice

Crime and the fear of crime are endemic concerns in contemporary urbanized societies. Crime prevention through environmental design (CPTED) is a branch of spatial practices that looks at interventions focused on place-based strategies for reducing crime, and the enhancement of spatial cognition as it relates to the perception of safety and security. As mentioned before, the underlying premise of CPTED is that for any crime, there are four dimensions to be considered: the law, the offender, the target, and the location.[3] Place-based strategies for reducing crime and the fear of crime focus on the site of crime as it relates to the spatial aspects of the target and the location that facilitates the criminal activity, and how both of these factors generate fear in the general populace, discouraging those who perceive themselves as the potential targets of a crime.

Location is an important dimension of crime because crime is not randomly distributed in contemporary urbanized areas: there are particular zones in each and every city that are identified both by the public and the administration as "hot spots" of crime, and therefore unsafe.[4] If a phenomenon has such a prominent locational specificity, it is just common sense to assume that spatial design has a direct influence on either its enhancement or reduction, and that "the proper design and effective use of the built environment can lead to a reduction in the fear and incidence of crime, and an improvement in the quality of life."[5] Such an assumption has led to numerous studies on the subject since the mid-twentieth century.[6]

In its first generation, CPTED includes individual components such as territoriality, surveillance, image/maintenance, access control, activity program support, and target-hardening.[7] Territoriality, access control, program support, and target-hardening look at techniques of clearly defining boundaries and the preferred use of a given space. Surveillance, whether naturally, mechanically, or digitally administered, makes the offenders visible to others, which implies to the potential offender that he or she is more at risk of observation and apprehension. Natural surveillance is a result of clear lines of sight and public inter-visibility, as well as an optimal relationship between the number of users of a space, its size, and the proper density of a given zone within an urban area. This means that isolated urban zones that are less populated are more prone to criminal activity, and such areas are more feared by those who perceive themselves as potential targets of criminal activity.[8] Examples of mechanical surveillance are street lighting and CCTV. An example of digitally administered surveillance is the grassroots reporting/streaming of criminal activity by citizens with handheld devices equipped with capturing and connectivity behavior.

Furthermore, proper maintenance of a space signifies a sense of ownership that is influential in reducing the fear of crime. Through proper spatial design, physical features of the environment can be arranged to offer a high probability of refuge and escape for the potential target of the crime, and a low probability of refuge and escape for the potential offender, reducing both risk and fear of crime.[9] The first generation of CPTED focuses on reinforcing positive behavior within the physical space through the use of physical attributes to separate public, public-private, and private space. These strategies define ownership and acceptable patterns of usage, in addition to promoting opportunities for surveillance that facilitate institutional control, and promote legitimate users' informal social control.[10]

First-generation CPTED insists on the principle of eliminating any unassigned spaces, ensuring that all spaces have a clearly defined and designated purpose, and are routinely cared for and monitored.[11] For example, improved lighting in public, open spaces has been categorized as being an effective intervention that "works."[12] Related to this approach is promoting design strategies that create more pedestrian-friendly public or semi-public zones within the city. These areas that welcome more public use are less likely to host criminal activities because of the natural surveillance resulting from a significant public presence within a shared space.[13]

Although first-generation CPTED has proven effective in several cases, there are also various shortcomings. First, "irrational" offenders—those intoxicated by drugs and alcohol—are potentially less likely to be deterred by first-generation CPTED strategies. Second, negative socio-economic and demographic dynamics can also reduce the efficacy of CPTED strategies: on one hand, social conditions may nurture fear, reduce the inclination to intervene, and result in an individual withdrawing into the home that is heavily fortified.[14] That is, when CPTED is applied without sufficient community participation and becomes overly reliant on target-hardening, mechanical and formal surveillance, access control, and the intensification of a "fortress mentality" can result in citizens withdrawing behind walls, fences, and fortified homes. On the other hand, first-generation CPTED principles like access control, surveillance, clean lines-of-sight, etc., can be used by criminals to create safe zones for their operations.[15] Furthermore, the implementation of crime prevention measures in one area can "displace" existing crime in terms of location, time, tactics, targets and type of crime, instead of reducing criminal activity or the fear thereof in empirical, absolute terms.[16]

While first-generation CPTED exclusively focuses on space and location to reduce crime, second-generation CPTED extends beyond mere physical design to include social factors by adding risk assessments, socio-economic and demographic profiling, and active community participation to the pallet of tools that can be utilized by designers.[17] If first-generation CPTED is focused on location, second-generation CPTED is more concerned with situation; that is, the multi-faceted context of crime and fear that encompasses the locational, the social, the cultural, and the political subtexts of the reality and the perception of crime in an urban context. For example, in terms of surveillance, second-generation CPTED is focused on techniques that engender positive social activities and diversity to encourage the public to take ownership of their space and take advantage of natural surveillance, as opposed to a mere insistence on intensifying the mechanically administered methods of surveillance. Second-generation CPTED is designed to support social interaction and promote "eyes on the street" activity, relying on a triad of community culture, cohesion, and connectivity.[18]

The second generation of CPTED recognized that the most important measure is creating sustainable communities by looking at all issues in a holistic way, and especially though engaging the local people. To this effect, the initial task is to create and enhance a sense of belonging to a greater community, where a useful definition of community as a concept and a framework for intervention through design can be: "The web of personal relationships, groups, networks, traditions and patterns of behavior that exist amongst those who share physical neighborhoods, socio-economic conditions of common understanding and interests." (Community Development, 2001) This web can include extended families, networks of neighbors, community groups, religious organizations, local businesses and public services, youth clubs, parent/teacher associations, playgroups, elderly people's groups, and many more. The driving force beyond second-generation CPTED is the fact that these webs coming together in the interest of the community as a whole is vital to its sustainability. To this effect, second-generation CPTED supports institutions such as community forums, neighborhood management committees, and Development Trusts as venues for facilitating a civilized life and enjoying the benefits of being a part of a lively society.

In 1987, the United Nations World Commission under Gro Harlem Brundtland created the Environmental and Development Report, which provided the guideline for the second generation of CPTED to take full advantage of what it defined as resources: social resources (people), economic resources (making best use of them), technological resources, (ensuring sustainable development), environmental resources (making the best use of natural resources), and ecological resources (protecting and making the best of habitats, species, and ecosystems).

By utilizing these resources, second-generation CPTED focused on creating "balanced, mixed-use, walkable

communities as a new model for urban communities." To this effect, second generation CPTED offered both social and physical planning as possible tools to create communities that are balanced in terms of age, profile tenure, etc. The main suggestions for accomplishing this goal were as follows:

/1 Do not build concentrations of single-tenure social housing

/2 Bring private ownership into public housing areas

/3 Build a substantial proportion of affordable housing and low-energy design in all new developments

/4 Invest at reasonable levels to ensure quality development based on specificities of the site

/5 Recognize the relationship between housing and schools, and the role that schools play in improving educational opportunities for young people and contributing to social de-segregation

/6 Recognize the direct relationship between housing conditions and health

/7 Introduce "magnet policies" to attract active people with spending power back to socially isolated areas in poor condition

/8 Develop walkable streets that are pedestrian-friendly and promote sociability, community surveillance, and human interaction

/9 In laying out master plans, provide a careful treatment of corners and vistas and landmarks to make the urban space more readable to the occupants

/10 Create mixed-use spaces by incorporating residential, workspace, shops, studios and performance areas

/11 Provide living space over shops to contribute to 24/7 activity in the city and enhance the perception of safety and security

/12 Provide optimum density in urban areas and do not leave unmaintained, un-attended, isolated zones

/13 Focus on energy-efficiency, waste minimization, and the optimum use of resources

/14 Foster community and social welfare

/15 Enhance economic prosperity, especially employment and education

/16 Create neighborhoods that are close to shops, public transport, activities, schools, and recreational opportunities

/17 Provide social structures for communities' socio-political activism that offer opportunities for citizen participation and social influence on their own environment

/18 Pay attention to the accessibility of space for people with impaired mobility, as well as those who require care and attention

All of the above are guidelines for creating mixed-use, mixed-tenure, walkable communities, and have great advantages from a crime-prevention perspective. It is safe to claim that instead of the vision of segregated, fortified, gated communities that was the subtext of strategies promoted by first-generation CPTED theory and practice, second-generation CTPED was focused on bringing diverse social groups together and providing the socio-political and physical backbone for them to coexist in a peaceful manner and conform to accepted behaviors.

The first generation of CPTED was a collection of strategies to discourage crime. The second generation of CPTED focused on strategies to eliminate the reasons for criminal behavior vial sustainable, livable environments. The third generation of CPTED that is subject of investigation and contemplation in this report adds another dimension to the discourse, which is that of the synergies amongst CPTED, urban sustainability, technology, and the potential of networks.[19] The premise of third-generation CPTED is that a sustainable, green urbanity is perceived by its members and the outsiders as safe. Third-generation CPTED's focus on sustainable green environmental design strategies insists on practical measures, physically or cybernetically enhanced, that foster the perception of urban space as safe beyond mere concerns about crime. Furthermore, whereas first and second generation CPTED were of a more local nature, third-generation CPTED looks at security as a global issue and tries to provide a manual that can be utilized across geo-political and socio-cultural divisions.

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3

Third-generation CPTED

Urban-scale green, sustainable and technologically enhanced design strategies for fostering the perception of safety and security in cities

Our proposal for third-generation CPTED is presented as a quartet of places, people, technology, and networks, as these factors benefit from the principles of green sustainable design laid out in the previous section dedicated to the index of the general field of practice. This is not to say that first and second-generation CPTED are guidelines for devising the third generation. Yet, while the focus of the first generation manifested jn a fortified city mentality, and the second generation focused on a socio-economically balanced community and a well-maintained city for all [socio-economic and ethnic groups], the third generation of CPTED is more focused on reprogramming the urban space through digital means on one hand, and green technologies on the other. Yet, it also incorporates the principle of surveillance and control from the first generation, and effective physical design and socio-cultural diversity from the second generation.

For the first contributing factor in the proposed quartet, places, the following guidelines are proposed to design the physical layer of the city as green and sustainable within the framework of third-generation CPTED:

/1 Integrating into the fabric of the city a sufficient amount of public spaces to provide appropriate settings for collective activities and gatherings

/2 Integrating sufficient green spaces at various scales, including street vegetation, vertical green facades, green roofs, neighborhood and city-scale parks, and public gardens

/3 Fostering new developments that target mixed and balanced communities in terms of income level, social status, ethnicity, demographics, and tenure

/4 Supporting new developments and revitalization projects that aim to create new spaces, or re-program existing neighborhoods as mixed-use instead of single-use

/5 Optimizing the urban removal chain in terms of sewage management and garbage collection, taking into account technologies and cultural practices regarding recycling and grey water treatment, which can contribute to effective measures in dealing with health-related urban issues, as well as enhancing the image of the city as well-maintained and cared for

/6 Enhancing natural surveillance by providing sufficient street lighting at night, securing the required level of occupation and usage at all times, and refinin the fabric of the city via

environmental design interventions that provide clear lines of sight on the streets and eliminate the isolated corners and blank spots that host illegal activities

/7 Ensuring that no place in the city is a terrain-vague; that is, a place with no institutional supervision. This means that each and every square foot of the urban landscape should clearly and properly have a governmental or non-governmental patron, a legal entity, or a grassroots collectivity of the urbanites themselves responsible for its maintenance, security, and supervision

/8 Promoting revitalization and redevelopment projects that focus on grey or brown sites—that is, sites previously accommodating hazardous industries that have devastating effect on urban lands, or sites that are devastated by natural disasters or violent conflicts, or sites that have been previously occupied and are currently vacant due to economic or socio-cultural reasons, such as the relocation of industries or the immigration of residents

/9 Providing sufficient and effective public transportation infrastructure that not only contributes to the well-being of citizens by reducing the toxic emissions of private commute alternatives and single-driver vehicles, but also contributes to reducing traffic, which has a direct impact on the psychological well-being of citizens and the time-efficient optimization of urban living

/10 Allocating sufficient financial resources to the regular maintenance of civic spaces, including streetscapes and urban facades

/11 Allocating sufficient financial and human resources to providing public education, particularly for the young urban population, both when it comes to quality school buildings and hiring the required experts in education-related disciplines

/12 Providing efficient regulations for the construction sector in terms of monitoring the structural integrity, energy-efficiency, and quality of building proposals, both at the stage of issuing building permits and at the stage of supervising construction quality

/13 Providing financial support and the macro and micro-economic infrastructure to assist the low-income urban population in home-ownership, which in integration with large-scale, low-cost, zero-carbon housing projects, and infrastructures of providing employment and income for prospective buyers, can create a viable economic model for home-ownership

In a green, sustainable, environmental-design-integrated system, places that provide safe homes, secure employment, and well-maintained and cared for civic environments create a positive image of urban living that contributes to both the urbanites' standard of living and their image of their city as a desirable, safe, and secure environment to live and work in.

When it comes to the second contributing factor in the proposed quartet, people, the following guidelines are proposed to design the social layer of the city within the green, sustainable framework of third-generation CPTED:

/1 Providing the proper infrastructure for the individual to voice his concerns and communicate his needs and desires both to institutional agents and other members of the urban population. This will create a sense of belonging to a greater community, and ensures that the individual has control over the circumstances of urban living. Additionally, these infrastructures will solicit a culture of engagement, collaboration, and mutual compassion between the members of urban population

/2 Providing the proper infrastructure for communicating information about the most current state of the city, its challenges, and the work that is being done to address them; and about the urbanites' responsibilities for collaboration and proper conduct. This infrastructure can lay the grounds for effective inter-communication of citizens' and the governments' responsibilities to each other, creating a democratic and transparent social setting for managing urban life

/3 Providing an infrastructure for creating a sense of belonging and community in members of the urban population. This includes fostering community centers, neighborhood associations, non-governmental organizations, and other public entities that help gather individuals around shared goals, needs, desires, and ideals. In such a setting, each member of the urban community becomes a sensor-actuator of positive interventions; an effective analyst, an active reporter, and a provider of services within the realm of his expertise

In a system that integrates green, sustainable environmental design, social structures that provide opportunities for people to have a voice to communicate their needs, concerns, desires, and ideas with other members of the public; and provides venues for governmental agents to communicate with the public in a direct and less-mediated way, creating an environment of mutual trust between citizens and city officials. In an environment of mutual trust, each citizen perceives himself as an agent responsible for the well-being of the greater community. This will solicit more engagement from the public when institutions need to count on their contribution and collaboration to make things happen. This also creates a positive image of urban living based on an environment that holds citizens responsible for the city's

effective performance, as well as marking them as the beneficiaries of such improvements.

As for the third contributing factor in the proposed quartet, technology, the following guidelines are proposed for designing the technological layer of green, sustainable cities within the framework of third-generation CPTED:

/1 The integration of green technologies into the current, somewhat bankrupt urban energy paradigm. Green technologies of energy production expand the possibility of harvesting natural energy and incorporating zero-carbon and clean energy, such as nuclear energy, into the energy production chain. Meanwhile, green technologies of energy consumption aim to change urban living in terms of reducing the carbon footprint and environmental impact of consumption. Buildings that have an optimized design for heat gain and loss, depending on environmental context, and that benefit from the maximum impact of natural ventilation and lighting, are possible sites of green interventions. Furthermore, energy-efficient mechanisms such as vehicles redesigned to incorporate clean energies like electricity, or that augment fuel-based models of operation with other possibilities, such as hybrid cars, should be considered in this regard.

/2 Enhancing urban surveillance as green sustainable design relates to enhancing the image of the city in terms of safety and security through the use of cybernetic mechanisms. Embedded networks of surveillance should be integrated into the infrastructure of urban settings in a non-intrusive way to ensure the effective monitoring of civic spaces, while not contributing to the uncomfortable feeling of being watched by a Big Brother.

/3 The effective incorporation of urban informatics to decode the complex, multi-dimensional dynamics of the city in real-time, which allows institutions to contemplate the possibility of an effective and optimized urban management paradigm, where real-time information about urban dynamics provide the required level of transparency to anticipate and respond to what is just around the corner

/4 Providing venues to deliver real-time information about city dynamics to citizens will have a positive impact on their decision-making. Wireless services and interactive, urban digital screens are possible venues for transforming the city to a cradle of real-time information that will help citizens to evaluate the specificities of their contexts and the ramifications of their personal decisions. This will expand the sphere of the citizen's perception of their environments, empowering them and assuring them about their security, since every aspect of their environments is known and visible

/5 Providing cybernetically mediated venues for citizens to collaborate and contribute to the real-time knowledge of their city and what is happening in it. This provides an effective interface between the city and its citizens

/6 Augmenting physical structures and the built environment with cybernetic capabilities that allow them to sense their context and become actuated in response to emergent conditions, and the dynamic needs and desires of their occupants

In a system that integrates green, sustainable environmental design, technological structures that transform the city to a context-aware, smart, energy-efficient environment capable of effectively responding to emergent conditions and functioning as an informatics interface between the city's citizens and governing institutions not only enhance the performance of the city, but also foster its image as a democratic, transparent environment. A transparent city is a safe and secure city because no corner is hidden and no fact about it is unknown. People are afraid of what they cannot see and what they do not know. Transparency eliminates the fundamental reasons for fear when it comes to urban living.

As for the fourth contributing factor in the proposed quartet, networks; before providing the index of guidelines, it is worth mentioning that the network is the glue that holds the quartet together. This is due to the fact that the network as a concept provides the required structure for other three factors. Physical networks connect places, securing the efficient distribution of human and material resources. Social networks, cyberneticaly mediated or otherwise, provide the required structure for creation of a well-integrated collective that contributes to sustaining the system. Cybernetic networks, wired or wireless, provide the connection between sensors and actuators situated within the city and the central control-and-command mechanisms that collect, store, and manage urban-related information. The very same networks also provide the portal for delivering real-time information back to the citizens in a very customized, personalized, and immediate way, particularly when we focus on wireless services and using personal handheld devices for accessing this information on online platforms. The following guidelines are proposed to design the technological layer of the green, sustainable city within the framework of third-generation CPTED:

/1 Properly designing and effectively maintaining the physical networks that connect places within the city. This includes networks of commute, energy networks, wired networks of communication, and networks of supply and removal, that is, water and swage networks

/2 Providing the wireless networks of information transmission that cover the whole city to provide access to online services to everybody, everywhere and at all times. This looks at the

possibility of transforming the urban landscape to what can be characterized as a Wi-Fi city, one in which hotspots where people can connect to the network and benefit from its services are everywhere

/3 The cultural and operational integration of online social networking into the everyday routine of urban living. On one hand, online social networks are effective in creating a sense of belonging to a greater community and fostering a sense of mutual trust amongst people. On the other hand, such cybernetically mediated memberships can actuate people and impact their decisions. Furthermore, various scenarios can be engendered by the potential of such platforms, particularly in terms of a culture of sharing resources. For example, targeted online platforms can provide a proper venue for car-sharing or ride-sharing. The most immediate scenario that comes to mind is for knowledge-sharing, such as that practiced in models like Wikipedia.

The proposed quartet addresses both the enhancement of the city's physical layer and also augments it with digital capacities, providing the city with a certain performative depth through the deployment of cybernetic constructs. The subsections that follow consist of an index of interventions. Each intervention is laid out as it relates to the above-mentioned criteria of places, people, technology, and networks. The vision that it offers is supported by similar projects developed by a multi-disciplinary team of researchers and experts at MIT SENSEable City Lab.

3.1

Urban surveillance: the use of harvested energy as a power source for street lighting

The global energy crisis has forced municipalities to cut back on their energy consumption in recent years. One of the areas in which these cutbacks have manifested is street lighting, which leaves publicly shared spaces dark at night. A comprehensive literature review of CPTED proves that sufficient nighttime street lighting has a positive impact on citizens' perception of safety and security. This is due to the fact that well-lit areas contribute to natural surveillance, discouraging the criminals who perceive themselves at risk of being observed, while ensuring the public of their safety by providing a clear view of the space that they pass through or linger in. Enhancing the network of urban street lighting with natural energy harvesting mechanisms to make it self-sufficient in terms of energy consumption can be a response to the global energy crisis, re-enforcing the urban electrification paradigm and its positive impact on the perception of security.

Aside from interventions that focus on harvesting energy on-site, another set of design strategies can target energy consumption and its optimization. Novel lighting solutions, such as LED lamps that have substantially reduced energy consumption, can be incorporated to this effect. A well-lit city becomes a 24/7 city, an always-awake urbanity that does not leave any dark spot open to criminal activity.

3.2

Enhancing urban surveillance natually: integrating greenscapes into urban streetscapes to create a more pedestrian-friendly urban fabric

CPTED research proves that urban areas that are empty, or do not appear to be well-maintained, generate a sense of anxiety in the passers-by, in addition to possibly accommodating criminal activities. As the streetscape of the city becomes more pedestrian-friendly by incorporating greenscapes, these publicly shared urban zones will be more frequented by the denizens, enhancing natural urban surveillance. People feel safe and at ease when they recognize that their circumstances are observed by others who happen to share the well-maintained, green, pedestrian-friendly streetscape with them. Aside from conventional modes of integrating greenscapes into the urban landscape through networks of small neighborhood parks and street-level vegetation, new technologies offer a plethora of possibilities for creating vertical gardens and integrating vegetal bio-organisms into architectural components, potentially transforming the image of our cities into well-maintained, green, and pedestrian-friendly spaces of habitation.

3.3

Cybernetically enhancing urban surveillance: a thousand Little Sisters instead of one Big Brother

Much research and practice in CPTED has focused on utilizing digital surveillance technology as a preventive measure for urban crime. This is well manifested in a post-9/11 proliferation of CCTV's in metropolitan areas like London and New York. Nowadays, surveillance cameras are everywhere, making some concerned about the Orwellian "Big Brother effect." It generates a certain level of anxiety to think that beyond each of these silent, mysterious, digitally enhanced devices, someone, somewhere is watching all of us: someone with whom we are not necessarily comfortable sharing our privacy. But instead of one "big brother" filming everybody, what if we allow individuals to become "little sisters" reporting their experiences to others in real-time, and in a multi-modal, high-resolution format?

The proposal for distributed surveillance, or "a thousand little sisters," is built upon the fact that in our contemporary cities, people are now equipped with personal handheld devices—smart phones—that are capable of recording their owners'

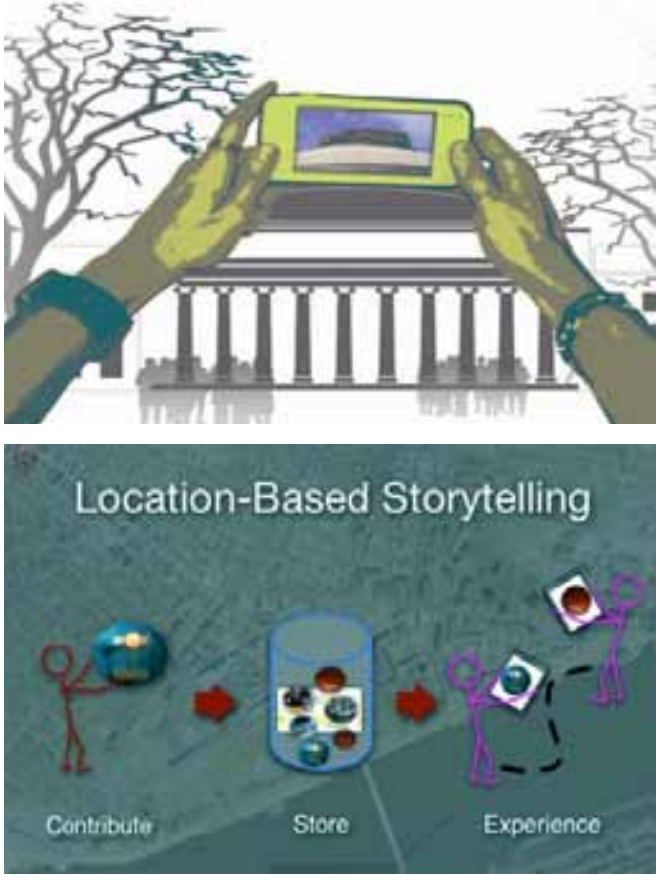
experiences in multi-modal format and in high-resolution. These mini-computers are also enhanced with a connectivity capacity that allows them to transmit the captured digital content via wireless networks of communication that provide wider-than-ever bandwidth for data transmission. This project can be thought of as a platform for a real-time Discovery Channel that extracts action from urban areas and delivers them in real-time to the wired world.

When we mount a device that digitizes personal memories and broadcasts them to distant recipients in real-time, the result is a subjective cinematic gaze that records and shares the personal account of an experience. Then everybody becomes like the protagonist of the movie *Man with a Movie Camera* (1929) by Dziga Vertov, making an experimental film that presents his experience anytime and anywhere. The result is a real-time, experimental documentary, and to the extent that it could be said to have characters, they would be the camera[wo]man of the title and the space, scenery, or spectacle she presents, whether that is the urban spectacular, an anxiety-driven situation, or a possible scene of criminal activity. This offers us a technologically enhanced platform for "sousveillance" as opposed to "surveillance." As Steve Mann explains in his description of the phenomenon, a system of surveillance (literally: watching [veiller] from above [sur]), scrutinizes subjects to see which are the first to "step out of line." Instead, in a "sousveillance" system, users are equipped with small, portable recording/transmitting devices, and will be able to enact the scenario of watching (veiller) from below (sous), "which can include personal experience capturing or [the] recording of an event by a participant in the event[,] or [one] who is just a passer-by or [a] silent observ[er]," and sharing it with others.[20]

The user of this platform transforms to a human camera and a networked cyborg entity in a sousveillance state, à la Mann.[21] According to Mann, this state will allow the subject to subvert his relationship to the outside world in terms of the power dynamic implicit in the idea of observing and being observed. Instead of being subjected to the "watchful vigilance from above," he becomes a part of a collaborative observance from below. This subversion of power allows the subject to be "filming as opposed to being filmed, shooting as opposed to getting shot." The subject augmented by such a technological platform, in becoming a member of a multitude, finds strength in numbers as "a part in a collective human intelligence."[22]

Furthermore, the technologically enhanced experience is alluring, since there is a certain appeal in seeing the world through the eyes of the Other. It is not only possible to temporally and spatially situate the reporting subject within the physical space by tagging the frame with information from the embedded sensors, but also based on contextual information, such as semantic and descriptive information provided by the user via the input interface of the capturing system. This creates a sense of belonging to a greater community, as the viewer of the real-time, audio-video streams sympathizes with the Other, the protagonist from whose viewpoint the story is being narrated. The contextual knowledge of the Other, including the orientation and location of his gaze, her speed of movement within the space, the level of action captured from one frame of the content to the next, adds another level of sensation to the experience of being visually teleported to a landscape. Furthermore, since the proposed system uses broadband wireless communication networks such as 3G and Beyond for data transmission, the previously mentioned viewpoint does not have to be a fixed one. Rather, the shared experience can be from the point of view of an entity on the move.

> Figure 1: Illustration of the high-level concept for GEOBlog. The illustration shows how digital information about a specific incident on campus is retrieved once the user tries to establish a connection with the system using a Nokia N800 at the location where the incident occurs. The incident referred to in this visualization is a historically famous prank where students placed a fire truck on MIT's great dome, covering the Building 10 entrance lobby.



3.3.1
CASE STUDY - GEOBlog: community-based digital storytelling (SENSEable City Lab)

MIT's GEOBlog is a platform for digitally annotating space for

the purpose of collective, community-based, digital storytelling. This Web-based platform allows people to annotate its virtual space through geo-tagging and sharing user-generated content, or in other words, placing digital content over spatial zones so that it can be retrieved by others based on the system sensing and locating it in real-time and in physical space. The platform has been implemented on the MIT campus, and builds on previous research projects at SENSEable City Lab that focused on providing the campus with location-based services. GEOBlog allows users to explore the campus as a spatial, collaborative blog that is open to personal stories, self-expression, and shared memories, showcasing the institute's unique and pervasive system of wireless technologies and its invaluable culture of collaboration, communication, companionship, and compassion.

In the context of green, sustainable environmental design that enhances safety and security, if a city-wide platform for collaborative, location-based, digital storytelling is implemented and made accessible for contributing or retrieving digital content via personal handheld devices, this will generate a sense of community that can help to enhance the image of the city as a safe and desirable environment. This type of platform would also allow for self-expression and making connections with other members of the community.

3.3.2
CASE STUDY - Mounted Mobile Camera Casts: a platform for citizen-reporters (SENSEable City Lab)

Mobile Mounted Camera Casts is a platform for conveniently conveying the sensations attached to experiencing the landscape of a city. The platform allows for a real-time streaming of the experience of the city via handheld devices equipped with sensing, audio-video capturing, and high-speed wireless connectivity. The multiple, mobile, real-time casts will be available on a Web interface or broadcasted channel where the location/orientation of each mobile agent is visible on a navigable interactive map, along with other contextual information that allows users to be able to locate the point of view they're seeing in real-time. Through pixel manipulation and action detection algorithms, the system will compare action—or changes in what is being captured—in the broadcasted frames by comparing the content of each frame with the previous ones, and attaching contextual information that favors the frame indicating the most visual action over the frames where no action is detected. By providing a platform for individuals to share their tempo-spatial experiences with others in real-time and across distance, passive inhabitants of spatial settings will transform into active, self-reporting agents who comprise a dynamic public sphere.

The project is composed of the apparatus and the backbone system that allows the users to share their audio/visual field in real-time with others, broadcasting via a 3G wireless cellular network while each frame is automatically annotated with location, and temporal and contextual meta-data. No matter how much more sophisticated audio/visual capturing

> Figure 2: Concept illustration for the Mobile Mounted Camera Cast project: What if instead of one Big Brother filming everybody, we allow everybody to become a Little Sister...a concept illustration inspired by Steve Mann's elaboration on surveillance. SENSEable City Lab ©, Nashid Nabian ©

> Figure 3: Interface strategies for delivering media content: an interactive 2D map viewed in a perspectival fashion, where the location and orientation associated with video content are also delivered to the viewing party. SENSEable City Lab ©, Nashid

technology becomes, or how much faster our wireless connections are in the near future, the experience offered by the platform will have a certain appeal: enabling users to experience the world through the eyes of the other in real-time; and enabling the users to become self-reporting agents—a thousand little sisters. This digitally enhanced spatial phenomenon also functions as a medium through which subjects within the space communicate amongst themselves, transforming them from observers of the technological spectacle to active participants of spatial scenarios in a networked condition.

In the context of green, sustainable environmental design strategies that reduce the fear of crime, this project is an example of the "thousand little sisters" discussed at length in the previous section dedicated to that project proposal.

3.4

Enhancing a citizen's sense of belonging: interfaces for accessing real-time information, conflict mediation and productive discussion

This proposal examines how civic zones of the city can be transformed into responsive environments through technological mediation. This would change the passive inhabitants of the city to active participants of spatial scenarios, and the public spaces from fear zones one passes through to urban destinations containing perpetual eventfulness, which enable the city's inhabitants to engage in fleeting civic encounters.[23] Making publicly shared spaces interactive can also introduce a new notion of spatial democracy and socio-spatial transparency, thus enhancing the public sphere, as well as the image of the city as a secure environment.

Currently, a major trend in designing for social interaction in publicly shared spaces is taking place in the field of locative media: digital content is geo-tagged and physically placed at different localities in the space. The content can be provided by a particular source, or it can be created collaboratively. The way that individuals experience this hybrid space populated by geo-tagged content depends on how each navigates the space corporeally. Subjects retrieve multi-media content using handheld or worn devices. Social interaction happens under the condition that a mediating system is aware of the engaged parties' locations, patterns of movement, and who or what is in their vicinity at any given time. Once a publicly shared space is digitally augmented so that it functions as a mediator, it becomes a spatial setting full of the potential for inter-subjection and collaboration, creating a vibrant public sphere. The very existence of this public sphere depends upon a physical space corporeally co-habited by those who participate in the process of generating a discursive, inter-subjective realm.

Although the cyber version of the public sphere is not a substitute for physical public spaces, its aspects of discursive/semantic interactivity, peer-to-peer interconnectivity, and real-time inter-subjectivity can be considered an ideal model. As a result, the idea of digitally augmenting physical public spaces seems obvious. Our hypothesis is that through blurring the borderline between the virtual/digital and actual/physical modes of social representation, and through augmenting the physical with the digital in urban settings, the public space canbecome a catalyst for direct human-to-human interaction, which would result in the rediscovery of the public sphere and new modes of democracy, promoting the image of a secure urbanity.

In the conception of this premise, we are inspired by practices happening outside of architecture in the field of locative media and interactive, media-art installations, as well as new, radical activist practices like sticker movements and flash mobs; or even not so new civic movements like street graffiti. For example, the digital version of graffiti that can be delivered on digital screens embedded and situated within public spaces is ephemeral and does not fall under the category of vandalism, yet still offers a public, civil platform for self-expression and social engagement. Most of these projects promote "fearless contact with strangers, playfully supporting relaxed encounters and sensitive interaction using appropriate ways of communication," without compromising the participants' privacy and violating their zones of intimacy.[24] Furthermore, overlaying the physical space with a digital layer brings the potential of Internet discussion platforms into the urban space.[25] The result would be a public of participating agents actively engaged in the process of recognizing each other as members of the same civil collective, and developing a social conscience around digitally-enhanced, shared memories hosted within an actual physical setting.

This melting of the boundary between the reality and virtuality of our civic activities will irritate some by making invisible electronic phenomena unavoidable, inviting information-overload or a violation of privacy.[26] Yet to our mind, the field is worth studying in a more focused and scholarly fashion, since the result of implementing this technology would be the activation of a conscious sort of civic participation and the creation of new forms of public spheres in our urban spaces. In this view the public space is an open (art)work, dependent on the people's intervention and utilization of their creative potential for animating and co-designing shared urban settings. In the end, the new modality of a participation-based society would generate a feeling of involvement missing in our contemporary modes of civic cohabitation.

In these circumstances, the goal of a designer is to come up with ideas for making a city a more desirable place. A desirable city offers a platform for reinforcing identity through communicative acts, a sense of belonging to a greater entity, and the creation of culture, the latter through continuous collaboration. Individuals need to be constantly acknowledged by fellow humans through what we call the simple act of making a difference. The more advanced the human race becomes, the more the members of this race seek opportunities to make their individual imprints on, and contributions to, society.

Take the concept of democracy for an example: democracy for us is the opportunity for each individual to make this type of personal and political difference. In the conventional relationship between the city and its denizens, this opportunity is provided through political acts like voting for city officials or governmental agents that can affect different aspects of city life. But the city itself is made of solid material, and it is hard for an individual to make a difference within the fixity of the built forms that give shape to the overall entity. However, digital technologies are adding a new, ephemeral dimension that is open to modification and change initiated by the individuals who inhabit it.

Collaboration on defining and redefining the ephemeral dimension of the city can be viewed as one way of making it more engaging, and making its citizens more invested in it. A city that is open to individual modifications enables subjects to imprint intentional traces of themselves upon it. This way, everybody becomes a graffiti artist and the city itself becomes a limitless canvas, resulting in a constant feed of grassroots eventfulness, subjectivity, and inter-subjectivity. We think this is the idea of Web 0.2. Whereas the previous version of the Web was used to find information and different services, Web 0.2 focuses on the collaborative generation of cultural capital through API's, blogs, Mashups, wikis, and other forms of soliciting user engagement. Now non-programmers can get involved and make a difference. In the digitally augmented City 0.2, the inhabitants are not the passive recipients of the landscape, but can get involved in the expansion, arrangement, and rearrangement of its digital layer, reclaiming the city as part of their identities.

Let's leave these thoughts and go to another aspect of this idea of the city as the platform of self-expression. Self-expression needs a medium through which the agents interface with the platform. Cell phones are great prosthetic extensions of their owners that can be used as input devices for this type of interface. What if one could use his cell phone as a remote control to change the arrangement or characteristics of the augmented, digital layer of the city; i.e., changing projected building facades, interacting with distributed user interfaces (screens), changing the configuration of the city's kinetic elements, leaving generated and shared content placed on or attached to locations, or providing participatory feedback in the form of rating any entity in the city?

In the concept of the public sphere as an embodied info-sphere, the mediating factor becomes technology itself. Technological mediation happens via two types of technological objects and structures. The first type of object is a personal computing unit like a mobile phone, while the second type consists of publicly owned and shared artifacts such as public digital displays and touch screens. In terms of structures, some scenarios for the digital augmentation of architectural spaces require the existence of an already-operational infrastructure. In the example of locative media, an infrastructure for location sensing is a prerequisite, and if the scenario is envisioned as transpiring outdoors, GPS locationing is a given. Indoors, a meshed network of presence-sensing probes or a Wi-Fi network should already be in full operation to host spatial scenarios based on location and context sensitivity. In other cases a massive operational infrastructure is not necessary, as the second type of technological structure supporting these scenarios is the peer-to-peer communication of handheld devices via Bluetooth, or ad hoc networks created via short-range radio connectivity.

To democratize a technologically implemented public sphere, the designer should keep in mind that the goal is to make the integration of the user-participant-inhabitants as easy as possible. This means limiting the technological requirements and privileging peer-to-peer instead of large-scale infrastructures. For example, if users interface with the digitally augmented space through a mobile application, designing the application exclusively for smart phones will limit the range of individuals that can integrate into the system, whereas providing a platform on SMS (instant messaging) will broaden the range of participants. In these ultra-accessible, peer-to-peer networks, every member has the same position as the others. Such a model revolutionizes inter-subjective relations, transforming the digitally augmented space to a public zone capable of accommodating the discursive inter-relationships. The non-places of modernity, the anxiety-driven public spaces of our contemporary cities, become fully capable of acknowledging the conscious input or implicit requests of the user-participant-inhabitants that actively create moments and situations.

As a conclusion to this proposal, the new contexts provided by the new media culture and technological achievements make it possible to implement a new genealogy of public spaces that are hyper-modern interactive fields for non-representative, discursive forms of democracy and civic life that promote fearless contact with strangers. Lastly, the augmented space will encourage conscious participation in the reconfiguration of the public space through depicting urban spaces as open, collective (art)works dependent on the people's continual

contributions and collaboration.

3.4.1
CASE STUDY - The Digital Water Pavilion: interactive public architecture (SENSEable City Lab)

The Digital Water Pavilion is a singular and innovative project of Milla Digital, implemented by Expoagua Zaragoza 2008 on behalf of the city of Zaragoza in Spain. Located in the connection node of the Milla Digital Expo site, this Pavilion of minimalist expression and small dimensions is simultaneously a sophisticated machine of high mechanical precision, a building appearing and disappearing thanks to a 12 hydraulic pistons system; and a place where spaces are flexible, changing, and responsive due to the action of 120 meters of water walls digitally controlled by almost 3,000 electromagnetic valves. The digital water curtain has the potential of functioning as an architecturally embedded screen for delivering information materialized as droplets of water.

> Figure 4: Photographs of the interactive water wall, animated and digitally controlled by almost 3.000 electromagnetic valves. SENSEable City Lab ©

The project explores the potential of interactive responsive architectures to transform public spaces to fields of interaction, play, and eventfulness. The interactive ephemeral facade consisting of a dynamic water screen engages passers-by, who try to play hide and seek with the wall. The public space transforms to the landscape of playfulness and fearless encounters with complete strangers who happen to share the same enthusiasm for its technology and dynamic performance. At the same time, the interactive facade can function as a portal of information that delivers digital content materialized as droplets. The Digital Water Pavilion fits quite well with the viewpoint discussed at length in the previous section dedicated to the project proposal, in that it is both a spatial device for social mediation within the public space, and an interface for delivery of real-time information. Both aspects tie the project to the idea of enhancing the image of the city as a safe and desirable place by mediating and easing social interaction in public spaces.

3.4.2
CASE STUDY - The Cloud: interactive public architecture (SENSEable City Lab)

The Cloud provides fuses two resources: energy and data–harvesting from both the natural ecosystem and humanity's complementary cybersphere. Rainwater trickling over its surfaces and displays is collected and redistributed. Wind energy, amplified at elevation, is harnessed. Photovoltaic inflatables at the fringes can be unreeled during the day and docked at night, or in high winds. Furthermore, in the Cloud display system, the patterns of its animated, spherical skins offer a civic-scale interface for the delivery of real-time information to the inhabitants and visitors of the city. The Cloud transforms a city's architectural icon to a display of ecological practices on one hand, and a large-scale platform for delivering real-time information on the other hand. This enhances the image of the city according to the discussion in the section above, transforming it into an interface for human interaction, and allowing citizens to develop a sense of belonging by influencing the built space through digital means.

3.4.3
CASE STUDY - Eyestop: urban furniture as a portal of digital information (SENSEable City Lab)

EyeStop is an exploration of the next generation of smart urban furniture; it aims to enrich the city with state-of-the-art sensing technologies, interactive services, community information, and entertainment. The project is partially covered with touch sensitive e-INK and screens so that it can deliver information seamlessly. Interactive, smart, urban furniture enhances how

urbanites interface with the city and how they conduct their day-to-day activities. If each and every physical component within the urban setting is endowed with capability to detect user-input and infer contextual information to solicit needs and desires, this extends people's sphere of influence, which has a direct impact on how user-friendly citizens perceive their city to be. As discussed before, the more user-friendly a city becomes, the more its image as safe and secure, convenient and desirable is enhanced.

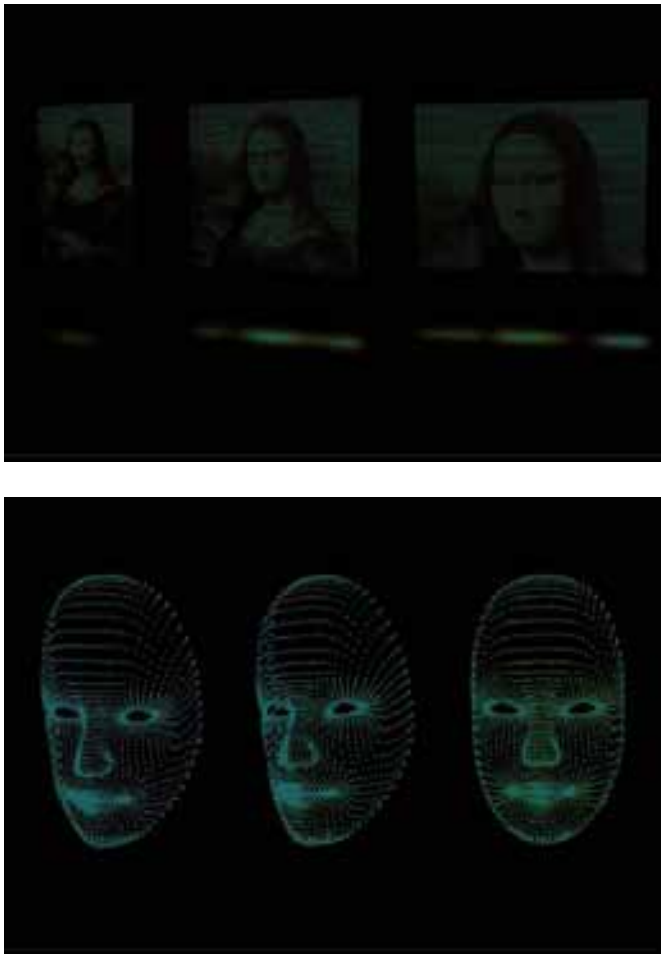
> Figure 5: Rendered view illustrating how information in graphic format can be projected on to the surface of the Cloud. SENSEable City Lab ©

> Figure 6: Rendered views of a possible implementation of EyeStop as a digitally enhanced bus shelter with interactive touch screens and E-ink digital displays. SENSEable City Lab ©

> Figure 7: Rendered view of a possible implementation of EyeStop as an information pole with interactive touch screens and E-ink digital displays. SENSEable City Lab ©

3.4.4
CASE STUDY - Flyfire: a new interface for delivering information (SENSEable City Lab)

Flyfire explores how display technologies can actuate the space of the city. It uses a large number of self-organizing micro-helicopters that contain small LED's and act as smart pixels. The helicopters are controlled to create synchronized motions and form elastic display surfaces. This allows any ordinary space to transform into a highly immersive and interactive display environment. The proposed mechanism explores the possibility of a free-form spatial display that consists of a swarm of pixels that self-organize in real-time to adapt to the requirements of any given scenario.



> Figure 8: Rendered views illustrating how Flyfire technology can be deployed for displaying raster information as two-dimensional, re-created graphics, and vector information as three-dimensional re-created volumetric compositions. SENSEable City Lab ©

3.5
Clarifying the dynamics of the city in real-time: enhancing the image of a city as transparent, well-maintained, safe and secure

This proposal looks at the possibility of sensing the dynamics of the city in real-time, and making this information available to both citizens and institutional parties. How can we sense a city and its dynamics? One approach is to utilise existing systems that have been developed for other reasons, but can function as a source of information on how our cities operate. We define this as viral sensing. The premise of such sensing practices is that the contemporary subject voluntarily and involuntarily leaves digital traces on various networks that are juxtaposed over urban areas. Once the datasets storing these digital footprints are spatially and temporally attached to entities and phenomena in the physical terrain, the urban landscapes that accommodate these traces are transformed to infoscapes. An infoscape, in this sense, is a digital terrain both temporally and spatially associated with the physical terrain.

Aside from tapping into existing networks, customized sensor networks can also be implemented to decode various flows within the cities. If a collectivity of sensors capable of communicating with a centrally managed server are embedded and distributed within a spatial context, the prospect of distributed sensing manifests as one aspect of a completely networked world, or an Internet of Things. Sensor networks employ a top-down architecture where all the sensors report information from the environment to a central database, from where this information is aggregated, managed, and stored. Instead of such top-down approaches, we should also consider more grassroots, bottom-up systems for sensing the dynamics of cities. One possibility is thinking of each urbanite as a human sensor, an agent for sensing and reporting on his or her individual experience through tapping into data generated by user-contributed content on shared platforms. Hence, we arrive at the third possibility of urban sensing: crowdsourcing.

User-generated content-sharing platforms allow everybody to report his or her experience to others in real-time, and in a multi-modal, high-resolution format. These platforms are repositories of what people "sense" in the city, creating a digital world that mirrors the physical one. The crowd using such platforms therefore becomes a distributed network of sensors that allow us to understand the dynamic patterns of the city and the experiences of its citizens. Incorporating digital technologies into the process of deciphering urban dynamics allows for a real-time analysis that can improve urban security.

Parallel to mechanisms of sensing, mechanisms of actuating are integral to cities that are cybernetic systems. In terms of

spatial actuation and regulation, we can speculate on two sets of possibilities. The first is regulating the landscape through actuator agents embedded within the space and controlled via algorithms that are conditioned by the information received from various sensing mechanisms. This vision opens up a multiplicity of possibilities for the design and implementation of responsive environments and interactive spaces by integrating digital technologies into the design of buildings and artifacts.

An infrastructure of flexible and on-demand actuators can make our daily interaction with urban spaces more efficient, productive, and customizable, enhancing the sense of control that individual citizens feel over their life in the city. The situated network of actuators provides newer tools for incorporating electronics and computers to mark territory, and can be bundled into perimeter fencing systems and transparent territoriality. These could function like "smart" fences that detect motion, vibration, and pressure, and that transmit information to central monitoring stations. RFID systems can be applied in an active and passive mode to presence and access control.[27] Other, newer access control devices that can be incorporated into the city-wide network of actuators include biometric systems that recognizes unique physical characteristics like hand geometries, iris patterns, voices, faces, fingertips, and blood vein patterns.

Yet, manipulating space through embedded actuators is not the only possible means of spatially regulating cybernetic urban systems. The inhabitants of the cities themselves can be considered possible agents of regulation and actuation. If the city is envisioned as the provider of real-time access to information for a body that corporeally inhabits it, spatial design does not limit itself to the allocation of material resources, but takes into account the temporal allocation of information relevant to the specific location or context of those occupants. The real-time and geographically situated information about the city and its dynamics can be fed back to the residents to help them make well-informed decisions. An example of this approach is the real-time, context-sensitive service offered by cellular networks that assesses crowd density based on cell phone usage in an area, which delivers this information to city residents who wish to identify popular "hot spots." In such scenarios, not the space but the inhabitants of the space are actuated, and the efficient regulation of spatial dynamics is based on their decisions.

The most promising characteristic of this integrated proposal for urban sensing and actuation is that it is made "smart" by the collaborative activity of its citizens. The citizens have the potential to function as sentient, self-reporting agents, contributing to monitoring the city as a cybernetic organism. A city whose inhabitants become sensors, and which is actuated by the results of the real-time information provided to them about its internal dynamics, will be more responsive to concerns about adaptability, efficiency, and optimal operation. Therefore, although augmented cities respond to concerns about function, structural durability, and aesthetic desirability, the focus of designing this type of space will inevitably shift to the issue of performance. After all, any space capable of self-adapting to new conditions is not there to merely endure, but to "perform" with efficiency. In the end, digitally augmented cities are performative cities. We end our consideration of this project proposal with the terms "user-participant-inhabitants" or "sensor-actuator citizens" to refer to the people who are its citizens, and who, we imagine, will be ultimately responsible for the cybernetic organism they inhabit.

3.5.1
CASE STUDY - Borderline: Mapping UK regions (SENSEable City Lab)

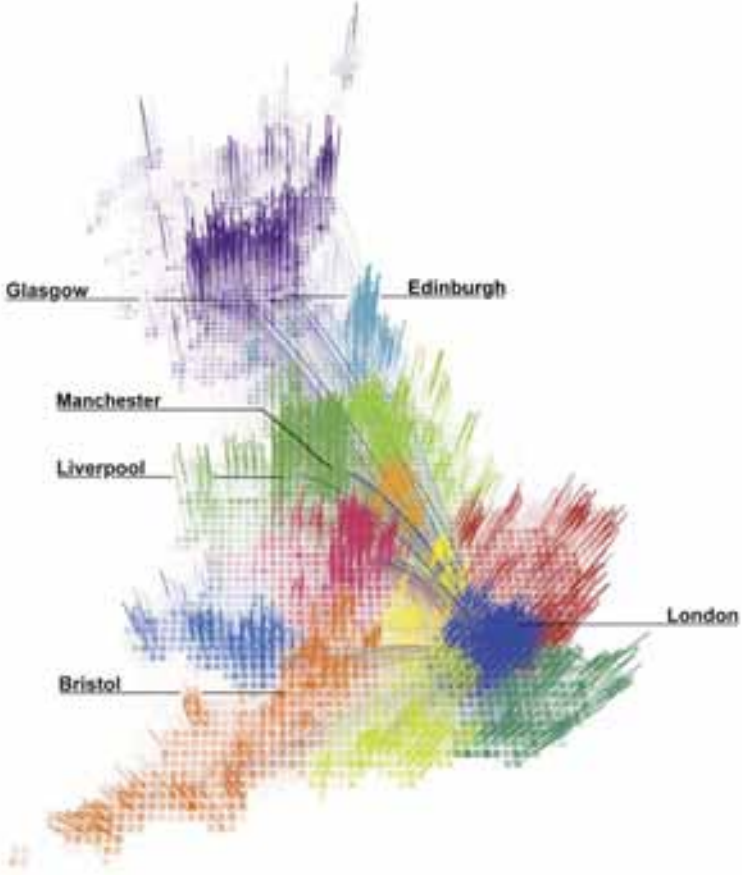
Borderline, a project by MIT SENSEable City Lab, is an example of the project proposal discussed in this section. Borderline is an attempt to redraw the map of Great Britain from a network of human interactions, inferred from a large telecommunications database in Great Britain. It examines the exactitude of socio-political boundaries defined by governments in respect to the natural ways that people interact across space. Incorporating the data extracted from the telecommunication network, given a geographical area and some measure of the strength of links between its inhabitants, the area can be partitioned through computational algorithms into smaller, non-overlapping regions while minimizing the disruption to each person's links, potentially creating a new type of spatial analysis that more closely reflects patterns of human interaction.

The process began by looking at the human network as a topological entity with no geographical constraints, but uncovered clear regions in space that respect spatial adjacency. Apparently, the telecommunication links between individuals—and the interpersonal transactions that they capture—are so intertwined with geographical space that partitioning at a network-topological level produces a very accurate partitioning of geographic space. The interesting point is that the core map based on human interactions seems to capture the reality of relationships between the members of the population more accurately than the official subdivisions of space.

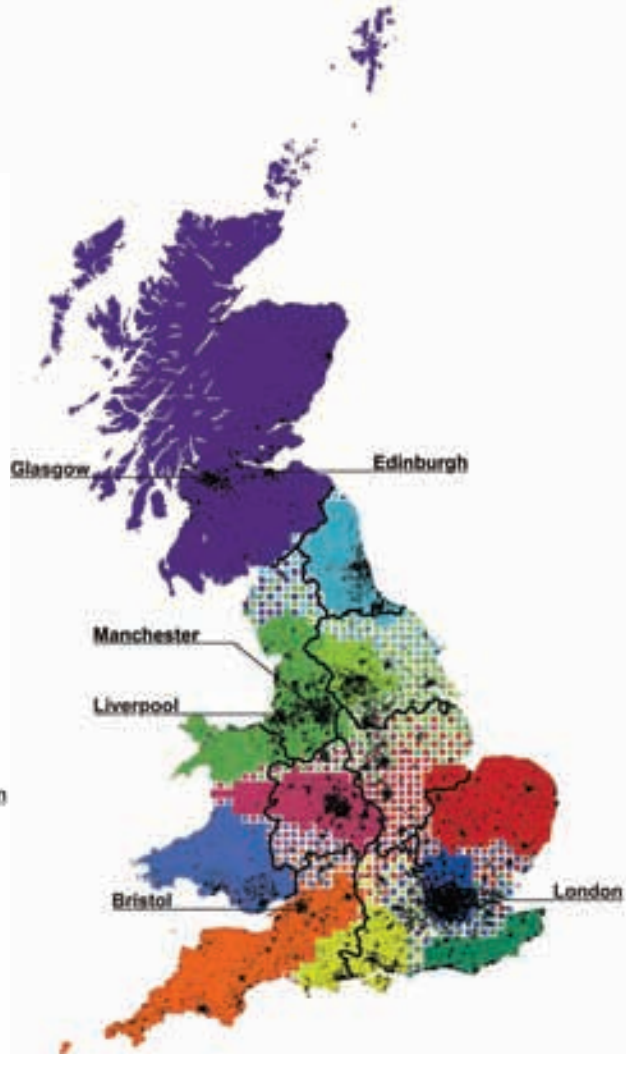
Borderline is an example of how viral sensing can unveil hidden aspects of spatial dynamics by analyzing the data sets that are the byproducts of telecommunication network usage. This type of analysis allows for drawing connections between how people interact and how they establish their socio-cultural networks across the spaces of urbanity. At the scale of a city, as well as a geographic region or a country, every phone call builds a connection between two places. Aggregating all

phone calls for an entire city reveals the connections amongst all places within that city. This "human network" can be utilized as a basis for how boundaries are drawn to minimize disruptions to people's connections. Once the reality of human connections are unveiled and compared to the existing boundaries, new spatial pockets and neighborhoods appear and others are redrawn, reflecting the more natural ways that people interact. The importance of this project in the context of green, sustainable environmental design and its impact on urbanites' perception of security is that most of the time how the space of the city is divided means that cohabitants of the same spatial pockets establish a sense of community and belonging with their neighbors. It happens that at times the official divisions do not correspond to the reality of how the inhabitants are divided into smaller communities; that is, the spatial divisions of the city interrupt the social network of its citizens. Such disruption or displacement can agitate the perception of security. On the other hand, if official divisions are laid out according to the reality of the geographical distribution of social networks, this can enhance the sense of community, and for that matter the perception of safety and security.

All of the above analysis is based on the pattern of landline calls, but the analytical method used in the Borderline project could easily be used on other networks in the future: data from mobile phones could be an indicator of more personal (as opposed to household and business-oriented) human interaction, while databases from credit card companies could highlight commercial links between individuals. One could even imagine applying a similar analysis to the movement



> Figure 9: The geography of talk in Great Britain. This figure shows the strongest 80% of links, as measured by total talk time, between areas within Britain. The opacity of each link is proportional to the total call time between two areas, and the different colors represent regions identified using network modularity optimization analysis. SENSEable City Lab ©



> Figure 10: The core regions of Britain. By combining the output from several modularity optimization methods we obtain the results shown in this figure. The thick black boundary lines show the official Government Office Regions partitioning, together with Scotland and Wales. The black background spots show Britain's towns and cities, some of which are highlighted with a label. SENSEable City Lab ©

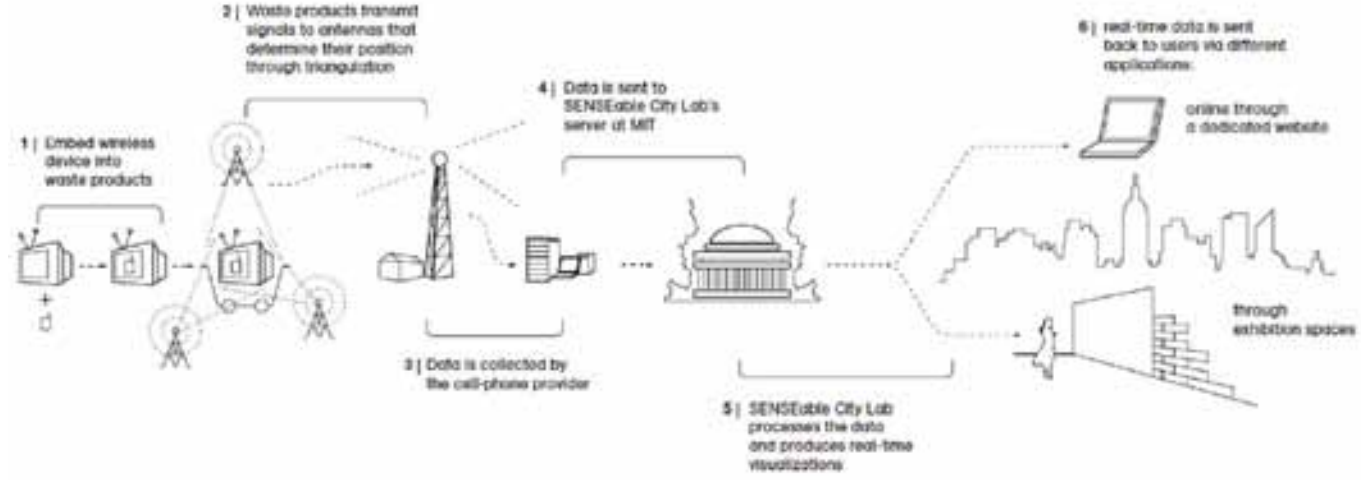
that would minimize their disturbance. All together, these approaches could lead to more optimal urban spatial divisions that allow for the least amount of disruption to various human activities, enhancing the sense of belonging to a more close-knit community.

3.5.2
CASE STUDY - Trash Track: implementing custom sensor networks for urban surveillance (SENSEable City Lab)

As previously discussed at length, a core principle of CPTED is that of transparency, or increased visibility within a space through the application of different technologies of surveillance. In third-generation CPTED, digital surveillance can be pushed to a new level of efficiency and effectiveness by implementing distributed sensor networks that allow for tagging and tracking entities within the city, both material resources and humans. The Trash Track project is an example of this "tag and track" principle. The project consists of digitally enhanced tags that can be attached to objects and report their location to an Internet backbone infrastructure via the cellular network. Trash Track makes use of these location-reporting tags to track urban disposal and study the efficiency of the urban waste-removal chain. The platform allows designers and planners to make well-informed, high-level decisions about how a given constructed landscape is managed by analyzing the acquired data. Therefore, a multiplicity of questions about the dynamics of the urban removal chain can be addressed empirically: is our removal chain efficient? Is hazardous waste managed properly, or are there loopholes in our system that need to be taken care of? Is the recycled waste really recycled, or does it end up in dumps? The Trash Track system can have a great impact on the nature of the perceptual relationship that a city or region develops with their waste.

Generally, people assume that once they dispose of waste it is no longer their responsibility. Offering a real-time view of how the disposed items travel through the landscape of their daily lives will perceptually expand each citizen's sphere of responsibility from the domestic space to the space of the city. Perhaps such real-time urbanity will lead to a more responsible urbanity. Yet, Trash Track is but one possible scenario in a more comprehensive concept of a world populated with Smart Objects that enhance the visibility of the urban space and its dynamics. Given the right technological platform, the only limits are those in our imaginations. A city that reveals all its hidden dynamics enhances its citizens' perception of safety and security since nothing is hidden about it. At the same time, depending on what is tagged and tracked and its pattern of movement the inhabitants of the city will establish a one-on-one relationship with the object through real-time access to its current location, enhancing a sense of ownership and belonging to the city that they live in and the artifacts contained within it.

> Figure 11: The custom-designed electronic tag for the Trash Track Project. SENSEable City Lab ©



> Figure 12: Diagram illustrating how the Trash Track tag periodically measures its location and reports that data to the server via the cellular network. SENSEable City Lab ©

> Figure 13: Sample visualization from the Trash Track project tracking a tagged aluminum can as it travels through the city's garbage collection network. SENSEable City Lab ©

> Figure 14: Sample visualization from the Trash Track project tracking a tagged plastic container of liquid soap as it travels through the city's garbage collection network. SENSEable City Lab ©

patterns of each individual, and determining boundaries

3.5.3
CASE STUDY - Live Singapore! (SENSEable City Lab)

Live Singapore! is an open platform for the collection, synthesis, and distribution of real-time data that reflect urban activity. Giving people visual and tangible access to real-time information about their city allows them to make their decisions more in sync with what is actually happening around them. In most cases, people moving within a city base their decisions on information that is static and does not reflect actual urban dynamics. However, companies and local authorities are increasingly managing their networks in real-time, always aware of the current state of the system. Yet this generated data is kept segregated, and while useful for each individual network's operation, it potentially contains much more value when put to creative use in new scenarios that combine data from different sources and make it accessible to the public. LIVE Singapore! closes the feedback loop between people moving through the city and the digital, real-time data collected in multiple networks, giving the data back to the people who themselves generate it through their actions.

To achieve this, LIVE Singapore! consists of an open platform for the collection, combination, fusion, and distribution of real-time data that originate from a large number of different sources. This platform is not aimed at one single application, but rather resembles an ecosystem and a toolbox for data that describe urban dynamics. Building on this platform, a community of developers can establish multiple applications that harnesses the creative potential of citizens who extract new value from real-time data. The relevance of this project in the context of a green, sustainable environmental design and its impact on enhancing the image of the city, is that it makes the real-time spatial dynamics of the city visible to its citizens. Transparency in how the city operates, if democratized and made available, does not just allow the citizens to make well-informed decisions. More importantly, it is in line with one of the core principals of CPTED, which is that of visibility. More visibility enhances the citizen's perception of having control over and enough knowledge about his environment, which in turn enhances the image of the city as an efficient operation, which contributes to the citizen's overall sense of security.

> Figure 15: Concept visualization for the Live Singapore! project that illustrates its core components. In developing LIVE Singapore!, the project addresses research related to the following areas:
1. Developing an urban, real-time data platform that allows collecting, processing, and distributing real-time data that originates in the city. This project explores solutions that can cater to a large number of streams of very different kinds of data, emphasizing the possibility of creatively combining multiple streams in the subsequent design of applications built on the platform. As many users will be using this system simultaneously, key aspects will comprise building a scalable and distributed infrastructure to smoothly distribute loads between platform and application providers without affecting the overall performance of the system.
2. Developing flexible and accessible API aimed at enabling a data query mechanism that allows users with little programming experience to easily tap the data pool brought together on the platform. In the context of the real-time data platform, a critical aspect concerns ways of efficiently finding and using these streams in a meaningful way. Users don't just search for static data, but real-time information that can change quickly: "where is the nearest store with my favorite product?" or "where are the most crowded bars?" The project leverages recent findings in semantic Web technologies to annotate places, data, and devices so that they can be processed automatically.
3. Developing interface and interaction models for a real-time data platform that explores possibilities beyond the two-dimensional views that have long been the most common way of representing and interacting with geo-referenced datasets. As Singapore is a vertical city, we explore how to structure real-time data streams using three- dimensional models, and how to visually access this information efficiently.
4. Developing visualization tools for urban data that help extrapolate meaning from the vastness of data produced by a city. In particular, emphasis is placed on developing a framework that allows designers to easily integrate, filter, and recombine data streams and display the results in forms such as maps, plots, etc. SENSEable City Lab ©

3.6

Capitalizing on the potential of online social networks to create a sense of belonging, to foster a culture of collaboration, and to transform the "me-mentality" of individual urbanites to the"us-mentality" of members of an urban, digitally enhanced multitude

Once the existing physical infrastructure of the city is augmented with a digital counterpart through the deployment of various situated technologies, the design should not focus on producing physical space in terms of expanding or augmenting existing urban infrastructures, but on adding new (digitally mediated) dimensions that result in behavioral changes in those who inhabit and commute within it. This results in an increased depth of usable space and allows for a more efficient use of existing infrastructures.

To this effect, the first premise of this section is the fact that through digital and telecommunications technology the city is sensed in real-time, and this information about spatial dynamics can be disseminated to create a feedback loop between the city and its citizens. Next, we argue that an incentive mechanism is required to guarantee the stability of the proposed integrated system and the continuous participation and engagement of citizens. Finally, going through various risks and potentials of the proposed system, we speculate on a new approach to dealing with urban growth as it relates to issues of safety and security.

Having access to real-time information actuates citizens, while the digital infrastructure provides an interface between them and the city from which they can retrieve information, or upload theirs. Access to information about how others live, work, and move within the city allows the citizens to grasp what is happening there, implicitly changing the perspective on urban living. The traditional view of urban living is based on an ego-centric understanding where "what I do affects me and involves me personally." The goal of this project is to change this to "what I do has an impact on the dynamics of the city at a global scale," and "any decision that I make impacts others."

This is the same mentality that governs online social networking platforms. Yet, novel digital and telecommunication technologies can be deployed to integrate data-sharing platforms within the spatial dynamics of the city. This allows us to share information about our choices with others and gives us access to information on how others make choices. The dynamics of sensing and sharing data plays into a certain collective awareness where citizens make sure that others are aware of what they do because they know that what they do is going to impact others. At the same time, they want to know what others do and how the city thrives as a whole, because it is going to have an impact on how they live in and enjoy their city. The system should provide incentives for people to actively modify their behavior, and check the results by retrieving real-time information about the effects of their decisions. This would allow them to modify their behavior again based on perceiving the one-on-one relation between their individual choices and how the collectivity of individuals' choices have global impacts.

Additionally, intensive research is required to address questions about how much one's behavior changes once there is a way to communicate its influence on the overall dynamics of the city. How does the community operate and what mechanisms can incentivize them to behave in a certain way? This allows for a particular urban living scenario where the city and its actuated citizens would function as an integrated system that reacts in a continuous feedback of information that impacts how people behave. To keep the loop going, the digital layer also needs to provide incentives for citizens to contribute different data streams and interact with it in order to make it a stable system.

Social networks can provide a platform for a performative and realistic incentive mechanism that functions as the social glue that keeps this feedback loop running. The question is how a social network can influence how much one's behavior changes in a given context, which in this case is facilitated through the delivery of real-time information about the impact of personal decisions. The resulting cybernetic, responsive system is a combination of one's own feedback loop and the community's feedback loop, with social networks both holding this hybrid system together and incentivizing members to change their behavior.

Aside from proposing systems of incentives, the project focuses on the potential and risks of deploying such a cybernetic feedback loop between the city and its citizens. After all, the promise of digitally augmenting the city comes with certain risks. For example, once information about different aspects of urban life is democratized and available to all citizens, it defeats the purpose of the proposed system if everybody reacts at the same way at the same time. The challenge is to find mechanisms to make such a system stable

so that how people react does not negate the initial purpose of integrating such a system to infrastructure of the city.

At the same time, the potential deals with the relative ease of scalability of digital systems. Whereas manipulating the physical world is time-consuming and demands large financial investments, expanding and modifying digital infrastructures can take less time and financial investment. Focusing on the scalability of digital tools, we will try to link their potential application to urban growth beyond the traditional tools of managing physical space, such as increasing the density of infrastructures or expanding their territorial reach.

The scalability of digital infrastructure can be evaluated from two different, yet closely connected perspectives. First is its distributed nature, where mechanisms of sensing and actuation become ubiquitous and embedded throughout the city. Second is the exponential rate at which information can be distributed within a digital infrastructure, which addresses the extreme potential of such systems in terms of what can be defined as virtual scalability: in data-sharing platforms, I can share my data with ten others or tens of thousands. The scalability of the physical infrastructure is nowhere near as flexible as the digital one. The question is how this sort of difference can be leveraged when it comes to dealing with concerns about security, particularly in reducing the fear of crime in the context of extreme urban growth.

Our cities are having a hard time keeping up with explosive urban growth through traditional approaches such as expanding or augmenting physical infrastructures. Implicit in our vision is a proposal for limiting the physical growth of the city, sticking to the limits of what we have and making it more efficient by integrating or adding a digital layer that increase the depth of how the city is explored, used, and experienced by its citizens. At the same time, parts of the cities' physical layer need to be redesigned by integrating the first and second-generation CPTED guidelines and the visions offered by green, sustainable urban design. Both redesigning the physical layer and augmenting it with a cybernetic layer will help people feel safer and more integrated into the social environment.

Guidelines for redesigning the physical layer include: sufficient street-lighting; pedestrian-friendly streets and pavements; public parks and gardens at the neighborhood, regional, and city scales; well-maintained and efficient public transportation and its dedicated infrastructure; mixed-use neighborhoods; balanced communities that include families from varying social, ethnic, economic, and tenure status as opposed to segregated neighborhoods; community centers that provide services to various social groups with varying financial abilities to pay for these services; enhancing the opportunities for natural surveillance through redesigning the form of the urban fabric, and providing sufficient levels of occupation and density.

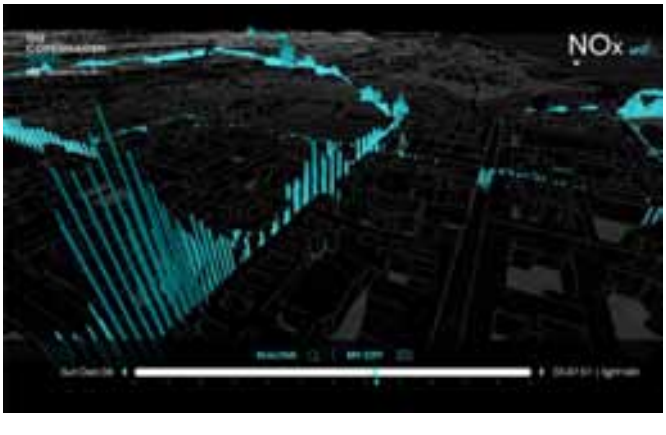
In increasing the virtual density of the city instead of its physical density, designers should go beyond their traditional task of providing guidelines on the production of space, expanding their speculations to the less explored domain of creating guidelines for changing the cultural norms and societal behaviors that regard how the space is used. Furthermore, spatial design needs to expand its reach to address the question of how the hybrid space of the city that emerges out of recombining the digital and physical layers is accessed by its citizens through effective interfaces. This project can be summarized as "The City as Interface," or an interface city.

3.6.1
CASE STUDY - The Copenhagen Wheel: socially networked, digitally enhanced cycling (SENSEable City Lab)

Smart, responsive, and elegant, the Copenhagen Wheel is a new emblem for urban mobility. It quickly transforms ordinary bicycles into hybrid e-bikes that also function as mobile sensing units. The Copenhagen Wheel allows you to capture the energy dissipated while cycling and braking and save it for when you need a bit of a boost. It also maps pollution levels, traffic congestion, and road conditions in real-time.

Controlled through your smart phone, the Copenhagen Wheel becomes a natural extension of your everyday life. Simply place your phone on the handlebars, and its Bluetooth module syncs with the Bluetooth module in the hub of the Wheel. You can use your phone to unlock and lock your bike, change gears, and select how much the motor assists you. As you cycle, the wheel's sensing unit also captures your effort level and information about your surroundings, including road conditions, carbon monoxide, NOx, noise, ambient temperature, and relative humidity. Access this data through your phone or the Web and use it to plan healthier bike routes, to achieve your exercise goals, or to meet up with friends on the go. You can also share your data with friends or with your

> Figure 16: Sample visualization from data on air pollution collected by the embedded sensors of the Copenhagen Wheel Prototype. SENSEable City Lab ©




COPENHAGEN
WHEEL

city—anonymously if you wish—thereby contributing to a fine-grained database of environmental information from which we can all benefit.

The Copenhagen Wheel easily turns the bike you already own into an electric bike with regenerative and real-time, environmental sensing capabilities. It differs from other electric bikes in that all components are elegantly packaged into one hub: there is no external wiring or bulky battery packs. Inside the hub, we have arranged a motor, a 3-speed internal hub gear, batteries, a torque sensor, GPRS, and a sensor kit that monitors CO2, NOx, noise (db), relative humidity, and temperature. In the future, you will be able to spec out your wheel according to your riding habits and needs. Live in San Francisco? Add more battery power. Interested in real-time applications? Increase the number of sensors. You own all the data that your Copenhagen Wheel collects. However, you might like to share it with friends through online social networks, gaining access to an even larger pool of information.

You can also make a bigger contribution through your daily commute by sharing your data anonymously with your city. When many cyclists donate the information their wheel is collecting, your city gains access to a new scale of environmental information, allowing it to cross-analyze different types of data on a scale that has never before been achieved. This can build a more detailed understanding of the impact of transportation on a city's infrastructure, or facilitate the study of dynamic phenomena like urban heat islands. Ultimately, this type of crowdsourcing can influence how your city allocates its resources, how it responds to environmental conditions in real-time, or how it structures and implements environmental and transportation policies.

The Copenhagen Wheel combines the power of social networks with distributed sensing and a sustainable, ecologically responsible mode of urban commuting into an integral package that can be described as responsible citizenship. The same approach to augmenting day-to-day artifacts of urban living with sensing and social networking capabilities builds on the fruitful potential of crowdsourcing and social networking, which can contribute to the perception of the city as secure and owned by responsible citizens who are welcome to contribute to its surveillance, to navigate it, and to customize their experience using smart technologies.

3.7

Technologically enhanced urban navigation contributes to the legibility of the city's fabric, easing spatial perception and enhancing the image of the city as user-friendly, safe and secure

Legibility refers to how easily one can find his way in the city, and how he can access city services with minimal time, energy, and financial cost. Ultimately, this contributes to the perception of safety and security on one hand, and fosters a sense of affinity with the city on the other. Location-based services improve the city's legibility and clarify the spatio-temporal distribution of its services. These services can be delivered on personal, handheld devices that are aware of the current location of the user, the time of the day, the identity of the user; the preferences either specified by the user in his profile, or provided by the user as input; the navigational patterns and habits of the user inferred by the system over time; and finally, real-time information about traffic and up-to-date routes of public transport.

While location-based services deliver customized information to a specific user, context-aware street signage augmented with sensing and connectivity capabilities can create a network of information display across the city that provides general real-time information. A combination of smart signage and location-based services contributes greatly to urban legibility. Smart signage that is cybernetically enhanced and equipped with digital displays can provide general information about the current state of a city, for example, informing drivers about heavy traffic and suggesting alternative routes. Or the signs can alternate between traffic information and air pollution information retrieved via wireless networks from city-wide weather networks. Smart signs can also be utilized as user-centric interfaces that provide humanistic, friendly hints on proper codes of conduct. For example, imagine a pedestrian light that not only temporally regulates pedestrian passage at an intersection, but also to detects when a pedestrian is jaywalking. Imagine that the sign's electronic interface changes to communicate its discontent in a seamless way to those involved in violation of law and the bystanders.

A place in which nobody is lost and it is easy to find services anywhere, anytime, offers the inhabitants a convenient urban infrastructure. Hence, citizens will feel more in control of their lives in a city that is nothing less that user-friendly. The city becomes a clear landscape, and the citizens feel a sense of belonging and security.

3.7.1
CASE STUDY - AIDA: smart navigation (SENSEable City Lab)

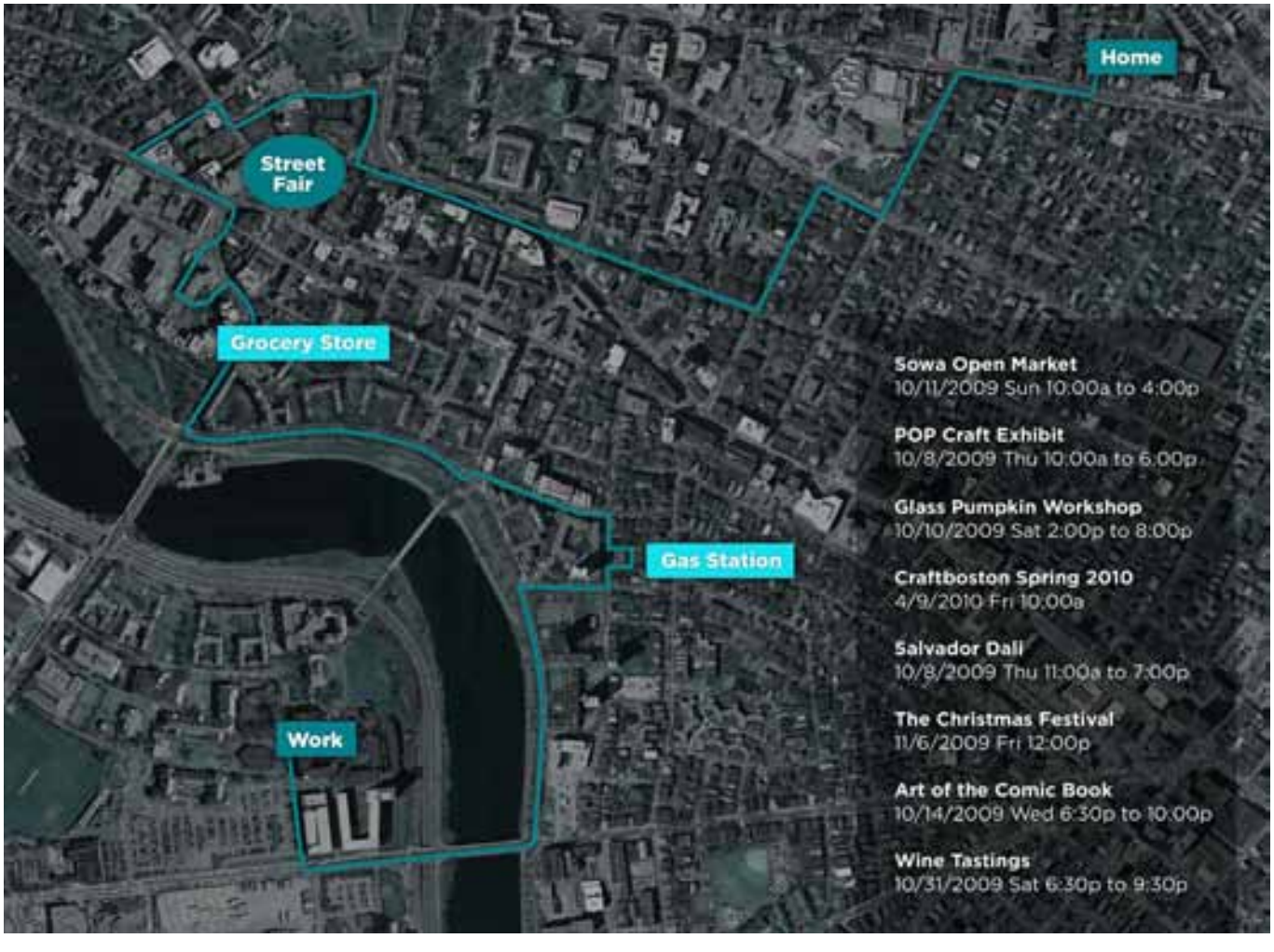
AIDA is an acronym for Affective Intelligent Driving Agent. The AIDA project, a collaboration between Volkswagen of America and the Massachusetts Institute of Technology (SENSEable City Lab and Personal Robots Group of Media Lab), is a platform comprised of a personal robot and an intelligent navigation system that aims to deliver an innovative driving experience. The navigation system mimics the friendly expertise of a driving companion who is familiar with both the driver and the city. Instead of focusing solely on determining routes to a specified point, the system utilizes an analysis of driver behavior to identify the set of goals the driver would

like to achieve. Furthermore, AIDA involves an understanding of the city beyond what can be seen through the windshield, incorporating information such as business and shopping districts, tourist and residential areas, as well as real-time event information and environmental conditions. Functionalities that gather other information about driver preferences help AIDA to behave more intelligently. One mandatory task for AIDA is to predict the destination of the driver, as well as the most likely route that he/she will follow. This will in turn allow for useful reactions, such as proposing route alternatives when something unexpected happens in the predicted route, or providing the right information at the right time.

With the ubiquity of sensors and mobile computers, information about our surroundings is abundant. AIDA embodies a new effort to make sense of these great amounts of data, harnessing our personal electronic devices as tools for behavioral support. In developing AIDA, much effort was focused on designing a system that would offer the same kind of guidance as an informed and friendly companion. AIDA communicates with the driver through a small robot embedded in the dashboard, reading the driver's mood from facial expressions and other cues and responding in a socially appropriate and informative way. AIDA communicates in a very immediate way: with the seamlessness of a smile or the

> Figure 18: Prototype of the AIDA Robot. SENSEable City Lab ©

> Figure 19: Figure 19: Sample Smart Context-aware Navigation Map Offered by the AIDA User-interface. SENSEable City Lab ©



blink of an eye. Over time, the project envisions that a kind of symbiotic relationship develops between the driver and AIDA, whereby both parties learn from each other and establish an affective bond.

To identify the set of goals the driver would like to achieve, AIDA analyses the driver's mobility patterns, keeping track of common routes and destinations. AIDA draws on an understanding of the city beyond what can be seen through the windshield, incorporating real-time event information and knowledge of environmental conditions, as well as commercial activity, tourist attractions, and residential areas. When it merges knowledge about the city with an understanding of the driver's priorities and needs, AIDA can make important inferences. Within a week, AIDA will have figured out your home and work locations. Soon afterwards the system will be able to direct you to your preferred grocery store, suggesting a route that avoids a street-fair-induced traffic jam. On the way, AIDA might recommend a stop to fill up your tank, upon noticing that you are getting low on gas. AIDA can also give you feedback on your driving, helping you achieve more energy efficiency and safer behavior.

3.7.2
CASE STUDY - Smart Signs: a tangible interface for collecting and delivering information (SENSEable City Lab)

Smart Signs is a system for retrofitting conventional commercial signs with digital technology so that they may report real-time information to a central server in order to make this information available to potential tourists. This platform can greatly increase a region's accessibility and appeal by providing real-time information about services and points of interest, while conveniently bridging the physical distance between potential tourists and their destinations.

The Smart Signs project proposes a platform for supplying and retrieving basic real-time information about the services offered in a city. The system augments conventional signage used to convey dynamic information about a commercial enterprise in situ, such as the ones providing services and information to tourists, including hotels, bed-and-breakfasts, restaurants, pubs, coffee shops, bars, and tourist information centers. The platform digitally augments these signs with network capabilities and sensors that register changes to the entities and report these to a central server. These are a natural interface for communicating information such as open/closed, vacancy/no vacancy to on-site customers and visitors, as well as those who check the availability of services online via the information-delivery component of the system. The sign apparatus does not introduce a new mode of user interaction that demands specific technical knowledge, but digitally enhances conventional modes of interaction. Hence, the Smart Signs can be easily adopted and used by individuals who are not computer savvy, or are not willing to change in their routine use of signs. The goal of the platform is to increase the visibility of small and local service providers, and to help them to work as a single body by integrating them into a centralized tourist information network.

> Figure 20: Concept visualization for Smart Signs, retrofitting the conventional sign with digital technology. SENSEable City Lab ©, Nashid Nabian ©

3.8
Establishing online platforms for municipalities worldwide to share their experiences with third-generation CPTED, and the criteria used to evaluate the results

Third-generation CPTED will not be effective unless it is applied on a global scale. This deployment should be regulated through a socio-political body with jurisdiction that crosses conventional geo-political boundaries to encompass all city municipalities. This type of global approach demands an infrastructure for exchanging knowledge and guiding a productive global discourse that surpasses national, continental, ethnic, racial, or geographical affiliations. Cyber-platforms fit this description in that the virtual infrastructure of discussion and interaction they offer is easily accessible to all possible collaborators across time, space, or any constructed geo-political or socio-economic divide. An online platform that allows all cities to collaborate in the creation of a global knowledgebase about the theory and practice of third-generation CPTED could be used by researchers and practitioners to host a wiki of theory and practice. At the same time, the municipalities that are registered in third-generation CPTED can have dedicated sections in which they share their current related practices, methodology, vision, and the outcomes of their CPTED-related projects. Through collaborative documentation of the state-of-the-art practice on a global scale, criteria for evaluating the success of the practiced strategies and applied theories can be established.

Furthermore, the online platform can also provide sections dedicated to the urban population of each city that is the

member of the consortium. These sections can include discussion boards for citizens to voice their concerns about urban issues and submit their viewpoints and proposals for potential courses of action. The very same platform can also be used to collect citizen feedback on the success of previously implemented strategies. The user-generated content can be studied by city officials and applied towards devising new theories and practice manuals. Intensive research on user-interface and information architecture is needed to secure the success of this global-scale platform to assure that the knowledge-based, cyber ecosystem is sustainable, and correctly conveys the range of global voices instead of fostering the viewpoint of cyber-lobbying interest groups.

Notes:

/ 20 Steve Mann, "Sousveillance," http://wearcam.org/sousveillance.htm (last accessed April 12, 2010).

/ 21 ibid

/ 22 Steve Mann, "I am a Camera," http://wearcam.org/mcluhan-keynote.htm (last accessed April 12, 2010).

/ 23 Antoine Picon, "Espaces Publics Espaces Dangereux," Géocarrefour, vol. 76, no.1 (2001): 23-26.

/24 Mirjam Struppek examines a series of digital augmentation projects of this particular socio-political nature. The documentation of her inquiry is available in the public domain @ http://www.interactionfield.de/.

/ 25 ibid

/ 26 In a 2003 art installation, Frequency and Volume: Relational Architecture 9, Rafael Lozano-Hemmer explores the unavoidability of the invisible electronic phenomena. For more information about the project, please consult its Web entry @ http://www.lozano-hemmer.com/english/projects/frequency.htm.

/ 27 Radio-frequency identification (RFID) is a technology that communicates via electromagnetic waves to exchange data between a terminal and an object such as a product, animal, or person, for the purpose of identification and tracking. Some tags can be read from several meters away and beyond the line of sight of the reader.

4

Third-generation CPTED and the post-conflict urban condition

The guidelines for third-generation CPTED proposed in this document are particularly relevant to dealing with the post-conflict urban condition. Post-conflict settings are often characterized by physical and human destruction or dislocations; a weak economy that either existed prior to the outbreak of violence or that results from a large-scale devastation of infrastructures; high rates of unemployment; a lack of security and a ubiquitous fear of returning to the conflict condition; and residual geographic, ethnic, or other tensions.

In post-conflict urban situations, environmental design must be an integral part of a comprehensive restructuring and stabilization program that focuses on improving the well-being of the affected population. General strategies for responding to post-conflict conditions include humanitarian assistance such as reintegrating displaced populations; rebuilding physical infrastructure (roads, railroads, ports, power, water, etc.) and providing public services; restarting and rehabilitating critical industries, clusters, and value chains; economic reform and providing jobs; building institutional capacities; employment and improving the welfare and living standards of the population; restoring the legitimacy of the government; expanding physical security; undertaking policy reforms; and providing mediation between conflicting parties. These strategies can enhance the prospects of sustaining peace and preventing a return to conflict and violence.

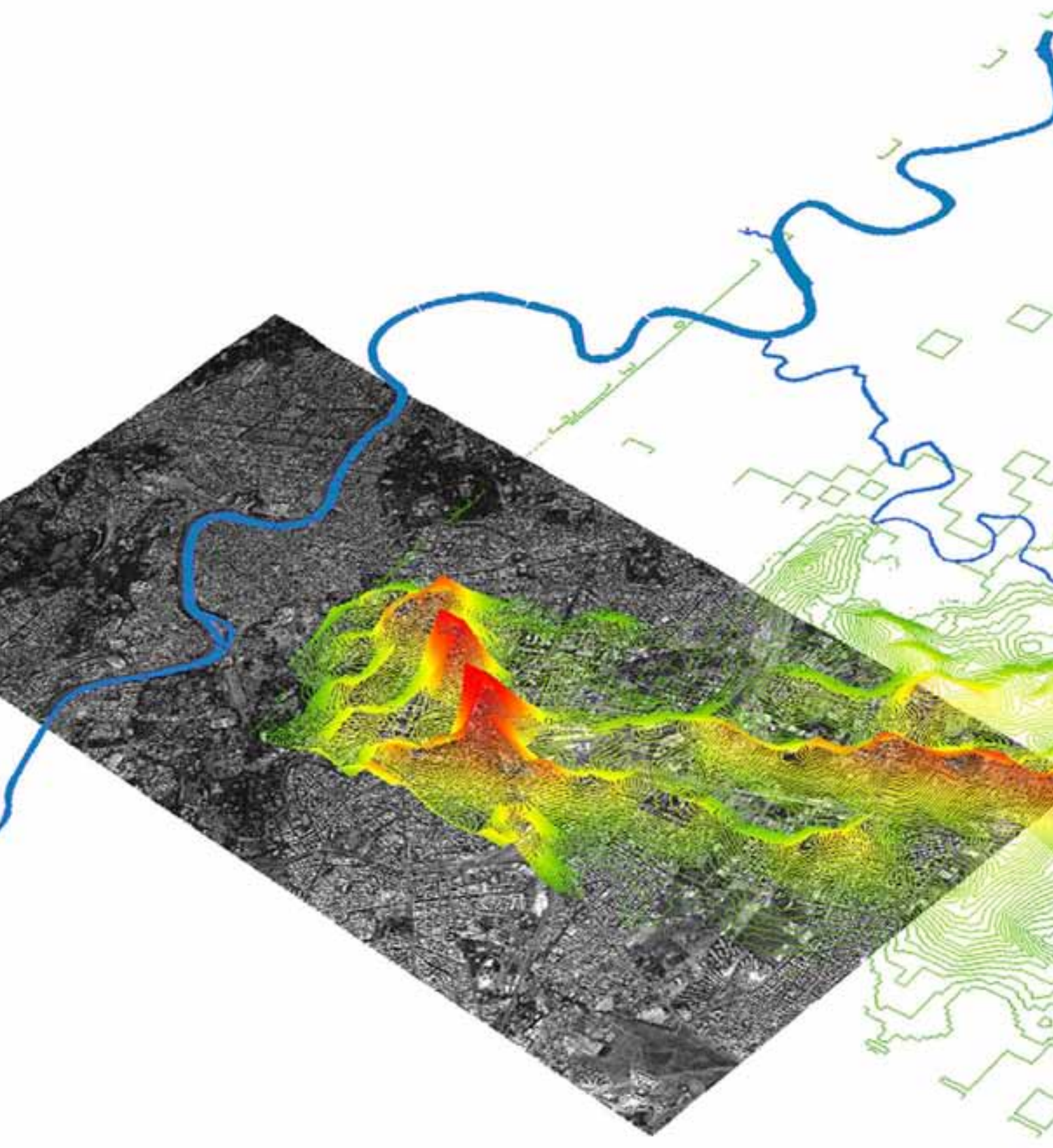
In this context, CPTED can help to achieve those goals. First and foremost, conflict reduces physical security, and the perception of security significantly threatens the rule of law in that conflict often leads to a breakdown in the government's ability to enforce the laws. In the aftermath of conflict, returnees are primarily concerned about going home to a safe environment to resume their livelihoods and rebuild their communities. The public must have confidence in the post-conflict government's ability to manage the situation. The tension between security concerns and the efficient flow of goods needed to restore physical infrastructures and rebuild a country's capacity to manage them makes the situation even more complex. People dealing with an uncertain and unstable future right after the conflict have a reduced confidence in the capability of their governments to control the situation, protect them, and prevent a return to violence. In this respect, CPTED guidelines for enhancing the perception of safety and security and reducing the fear of crime have utmost relevance. Furthermore, economic issues such as an inequitable distribution of assets and opportunities, or a widely held perception of inequitable distribution are very often the cause of an outbreak of violence. Economic growth is a straightforward way to prevent a return to conflict, and sustainable, green environmental design and third-generation

CPTED contribute to the vision of a sustainable economic growth.

At times, geographic, political, ethnic, social, or cultural tensions between parties with conflicting interests are the driving force behind a violent urban conflict. Sources of hostility may be very deeply rooted, and therefore very difficult to eradicate. Effective mediation can contribute to resolving these issues that are often foremost in the minds of the affected population. In this document on third-generation CPTED, various suggestions focus on how technology can be used to transform the space of a city to a conflict-free interaction field that actively mediates between parties with conflicting interests. For instance, cyber services that expand an individual's influence over his environmental circumstances and mediate his interaction with the political agencies and institutions, and technologies that contribute to transparent urban dynamics, enhance an environment of mutual trust between citizens and the governmental agencies. The development of this type of dialogue is critical, particularly given the fact that citizens' contributions, collaboration, and engagement is much needed in situations where the national or local government is weakened or/and has limited power.

The transparent spatial dynamics promoted by third-generation CPTED reduce risk and increase the predictability of the environment of post-conflict urban life. Moreover, CPTED strategies that look at the possibility of creating a sense of belonging to a greater community are also of relevance in the post-conflict urban condition, since community members should be involved in identifying targets for rehabilitation, as well as ensuring the inclusiveness of the post-conflict policies and decisions.

> Figure 21: Real-Time Rome combines different datasets in a single interface: real-time data, GIS data and raster images. SENSEable City Lab ©



5

Policy Remarks and Conclusions

As the world's population continues to grow, so do its cities and metropolitan regions.
Safety/security concerns about preventing crime and reducing the fear of crime have become more pressing, as every year more cities are feeling the effects of this situation.
For the first time in history, urban population exceeds the rural population and more than half of the world's inhabitants live in cities and towns. The world is going through a significant urban transformation, and such a metamorphosis has many consequences at the economic, social and political level. A new urban time is upon us.
While urbanization, migration flows, and social conflicts are increasing, the financial resources at disposal are decreasing and as a result so are the possible alternative solutions to these issues. That is why the need for **combined investment and solutions** becomes the only way out and that is why in the governance of cities, **the green environmental design must also lead to more secure and safer environments**. The city's budget has to be managed in a way to achieve multiple results through more intelligent and efficient policies.
In one word, today's resolution is to do more with less.
This report is not aimed at offering definitive solutions to the problems of cities, nor does it urge mayors or governments to adopt one policy or the other. Rather, its main aim is to provide a number of hands on and pragmatic policy suggestions based on the revision of the current CPTED theoretical framework. This would allow cities to meet some of the most urgent needs of the citizens like having a properly designed city with adequate services; less polluted more energetic and friendly environments; and a more safe and secure area to live in.
This momentous step represents a big challenge as, together with the cities' growth, also their complexity is rapidly increasing, turning metropolitan regions into laboratories for testing future solutions and its administrators into key international political players not only at the local level, but also at the global one.

This rapidly increasing urbanization is accompanied by an equally increased distribution of risks and burdens to two different extents: that of security and that of environment. That is why the joint work UNICRI Lab and MIT is intended to respond to three major changes that will shape the world in the coming decades: urbanization, climate change and security.
Therefore, the action of mayors and governments should focus on preventive responses and be oriented to impact on the perception of security of citizens through the sustainable regeneration of urban areas. Such a challenge has already been taken by several national and local administrators of major cities and the results have shown remarkable and measurable improvements. The result is that when the structure of the city is designed to keep in mind both

security and environment, the overall wellbeing of the citizens is improved.
Green regeneration of urban areas can effectively help in preventing segregation, crime and anti-social behaviours and, therefore, in combating fear. Societies can develop resilience to overcome crime and violence, insecurity of tenure, and insecurity in general. Some cities such as Medellin (Colombia), Daidema (Brazil), or New York (USA) have demonstrated that crime and violence can be reduced.
Urban design and architecture have an acknowledged impact on security: they are instruments capable of resolving existing problems, avoiding the outbreak of new ones, recomposing existing divisions and creating links between the cities' various areas.
However, beyond the idea of "plain" city planning, the city design can be developed to take into account sustainable and low impact solutions. The liveability, aesthetic, social and economic attractiveness and safety of cities need to be enhanced, and so does the efficiency of the cities' energy usage. Defining sustainable standards in the urban planning is a crucial asset to improve security governance; that is why, this report is intended to devise and promote new preventive urban security policies in more liveable habitats.
Starting from the above assumptions, this report analyzes the interdependencies between ecology, green urban design and security both of the citizens and, more in general, of the urban environment.
To this end, the report starts from the CPTED theory which is currently available to municipalities and which is not adequately updated to take into account both advances in new technologies and the pressing concerns about ecology and the environmental impacts of urban living. This creates a palpable exigency for devising a paradigm for CPTED.
The First-generation CPTED promoted a fortified lifestyle where surveillance, territoriality, and access control were used as the means to prevent crime. The second generation of CPTED, however, is focused on sustainable development to promote environmental design strategies that would eliminate the reason d'etre of urban crimes by creating livable, civilized, balanced communities in well-maintained urban settings. These conform to agreed-upon codes of conduct, while socio-political structures of interaction foster collaboration and enhance the citizens' control over their environment by providing proper venues for them to voice their concerns and contribute to the livability of their civilized urbanity.
Yet, the challenges that urbanity faces today are not limited to concerns about being able to sustain a safe and secure mode of operation. Cities also need to take into account the larger ecosystem in which they live: the planet Earth, with its depletable resources and fragile ecosystem. Hence, the cities of today and the near future need not only to be sustainable, but also green: designed and maintained in a way that allows them to thrive in a symbiotic and synergetic relationship with the global natural ecology.

In this context, the third generation of CPTED proposed in this report takes into account the rapid development resulting from new technologies. Digital and telecommunication technologies have transformed our physical world into a hybrid of materials and information. They have also enhanced the urbanites' sphere of influence through digitally retrofitted means while introducing new modes of living in a networked society. Network culture, the ubiquity of embedded electronics and digital devices, the pervasiveness of cybernetic sensing and actuation, the informatics revolution and exponential growth in our ability to store and manage large amounts of digital information that can now be accessed instantaneously and with ease, all signal the possibility of revolutionizing how we think about urban safety and security.
The third-generation CPTED envisages a green, sustainable approach to enhance the living standards of urbanites and improve the image of the city as user-friendly, safe, and secure. It focuses on a particular sort of spatial democracy and transparency characterized by the use of solid infrastructures and solutions, and of situated technologies. A transparent, readable city assures the citizens that each and every salient urban dynamic is unveiled and available to the public. At the same time, building on the potential of online social networks, third-generation CPTED aims to create a sense of belonging and membership to a greater community by soliciting citizen engagement and participation in improving the conditions of urban living.
Third generation of CPTED described in this report focuses on three main methodological branches. They suggest to the urban policy-makers an approach to be adopted when planning the security policies of the respective cities.

/1 Anticipate the dynamics of the city
The extensive application of sensing practices utilizing situated technologies allows for real-time access to urban information. The simultaneity of this information will help us not just to predict the future trends, but also to anticipate what is just around the corner. This allows for a real-time urbanism, or anticipatory urbanism.

/2 Collaborate on improving standards of living
Retrofitting the city with online and interactive functionalities can make it an interaction field that promotes a culture of collaboration among the citizens where social/human relations are capitalized upon for the greater good; that is, a sustainable, green city that is safe and secure.

/3 Sense and actuate the city
Sensing mechanisms can be helpful in gauging what is happening in the city, while actuating mechanisms can apply the principles of cybernetics to how the city is maintained, soliciting emergent conditions that are registered via sensing. Not only can the physical elements of the city be actuated, but the citizens themselves can also act as actuators. Access to

real-time information can direct their processes of decision-making and their behaviors towards a more sustainable, green, and safe lifestyle; that is, citizens can be mobilized in the right direction.
Aside from transforming a city to a sensed, collaboratively managed, adoptive, correctly mobilized urban condition, the third generation of CPTED offers criteria for measuring the effectiveness of its proposed strategies.
Firstly, the voluntary or solicited citizen input can be tapped through online platforms and social networks.
Secondly, certain indicators can be monitored by engaged parties in order to gauge the level of improvement in the perception of safety and security:

/a To what extent is the public space of the city used by the inhabitants not only as a transit space, but as a destination in itself?

/b To what extent have the new strategies reduced reported crimes and expressed fear of crime?

Finally, while previous generations of CPTED focused solely on physical interventions, the third generation introduces the prospect of effectively incorporating cybernetic interventions. This does not mean that it disregards the importance of strategies that solicit physical changes to the structure of urbanity, but that cybernetic modes of operation oriented towards affecting behavioral changes in citizens to achieve a more sustainable, green, mode of living should be added to the mix. This will provide new tools for citizens to interact with the space of the city, allow them to interface with the services it offers, and increase the depth of urban space in terms of efficient use and optimized performance and consequently increased sense of belonging and security

Both the physical and cyber layers of space and the potential of design based intervention need to be examined together to achieve more sustainable, green, ecologically responsible solutions.
The revision of the current CPTED theory into its third-generation suggested by this report proposes to design the physical layer of the city respecting the following recommendations.
These guidelines are to be taken as **concrete suggestions for policy-makers** in order to design effective environmental policies and take concrete measures that have an impact on the urban security and its perception among the citizens.

/1 Integrating into the fabric of the city a sufficient amount of public spaces to provide appropriate settings for collective activities and gatherings;

/2 Integrating sufficient green spaces at various scales, including street vegetation, vertical green facades, green roofs, neighborhood and city-scale parks, and public gardens;

/3 Fostering new developments that target mixed and balanced communities in terms of income level, social status, ethnicity, demographics, and tenure;

/4 Supporting new developments and revitalization projects that aim to create new spaces, or re-structure existing neighborhoods as mixed-use instead of single-use;

/5 Optimizing the urban removal chain in terms of sewage management and garbage collection, taking into account technologies and cultural practices regarding recycling and grey water treatment;

/6 Enhancing natural surveillance by providing sufficient street lighting at night, securing the required level of occupation and usage at all times;

/7 Ensuring that no place in the city is a terrain-vague; that is, a place with no institutional supervision;

/8 Promoting revitalization and redevelopment projects that focus on grey or brown sites—that is, sites previously accommodating hazardous industries, or sites that are devastated by natural disasters or violent conflicts, or sites that have been previously occupied and are currently vacant due to economic or sociocultural reasons;

/9 Providing sufficient and effective public transportation infrastructure that not only contributes to the well-being of citizens, but also contributes to reducing traffic, which has a direct impact on the psychological well-being of citizens;

/10 Allocating sufficient financial resources to the regular maintenance of civic spaces, including streetscapes and urban facades;

/11 Allocating sufficient financial and human resources for providing public education, particularly for the young urban population;

/12 Providing efficient regulations for the construction sector in terms of monitoring the structural integrity, energy efficiency, and quality of building proposals;

/13 Providing financial support and the macro and microeconomic infrastructure to assist the low-income urban population in home-ownership;

The suggested third-generation of CPTED is an all-encompassing perspective for the regeneration of cities. To this respect, other than only showing mere indications on how to distribute the city spaces, these solutions aim to re-think

this urbanized time, where solid structures and safe urban solutions can integrate with the new digital technology.

A different life-style is what we aim to reach through the use of this urban policy.

A new life-style where the citizenry is actively participating and living the city with a different approach. Mayors and administrators in general can offer a different structure of the cities, but citizens also must act more actively to ensure a more "democratic" and readable city. To this extent, an assertive participation can translate into more perceived security as it involves an active interaction of the citizens with their territory; it means to pass from the big brother society to the shared responsibility society. It means to find shared and common solutions for the collective wellbeing, and it also means to put all our **strengths to improve the level of life of the many instead of the few**.

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