A Competitive Model for Technology and City Planning: *The Synergy of a Digital Urban Grid, a Wireless Cloud and Digital Architecture*

Spiro N. Pollalis
Harvard University

Abstract

Our proposal focuses on the deployment of information technology in new cities aiming to support everyday life in an unprecedented way by providing: 1) functionality, 2) geographical interaction, 3) information navigation, 4) interactive governance, and 5) personal identification. Furthermore, it is proposed that the planning of information technology becomes an overlay of city planning and thus the synergy of the two becomes the competitive edge for the success of a new city. This technology overlay on the city fabric comprises the Digital Urban Grid.

There are three elements of information technology planning in a Digital Urban Grid: 1) the grid of the wired infrastructure, 2) the grid of public information spaces and 3) the grid of the Social Information Institutions. The three elements will have common nodes, where they link to each other. A fourth element, the wireless infrastructure becomes a cloud superimposed on the city and the digital urban grid. The wireless cloud is conceived to enhance and complement the digital urban grid. Such a systematic approach integrates institutional, public and private spaces as well as heterogeneous technology platforms such as electrical, optical, micromechanical and biotechnical.

The transformation of the Digital Urban Grid to Digital Architecture can take a series of parameterized shapes, creating an overlay of patterns on the city grid. On downtowns the grid can serve as an orientation tool as well as a source of information. The concept of the information pavilion network is an essential part of the Digital Urban Grid and a central concept in the design of a new city. Paired with an enhanced functionality of the wireless cloud and a re-definition of wireless devices and their functionality, the network of information pavilions will constitute a hub space to allow citizens and visitors explore and be immersed in the ubiquitous city.

1. Towards Success in a New City

Any new city must be successful. People and businesses must be willing to relocate and make it their new home. This must also happen relatively fast to generate a critical mass as quickly as possible. In addition, the city should be properly maintained to sustain a quality of life.

Our thesis is that in order to go beyond the immediate goal of simply filling the new city with people, today's new cities must have a high level of ubiquitous connectivity to be attractive and competitive. There must be a shifting of the paradigm in the way we live, work, learn, play, and be entertained. Access should be everywhere and anytime with a combination of mobile and stationary devices. Furthermore, albeit a paradox, ubiquity must have a visual presence in the city, to make it tangible, to relate to people and space. Thus Digital Architecture, the architecture of the physical presence of ubiquity, the series of places that enhance and support interaction becomes a central element in any new city.

The importance of the Multifunctional Administrative City (MAC) makes it a best candidate to set new standards. Success for MAC translates in making it a vibrant city, a place of choice, the new heart of the country, a model not only for Korea but for the image of Korea abroad. The task is much more complex than for the many other new towns built in Korea today. It requires the setting of clear and reachable goals, a systematic design of the physical and the virtual overlays, and inspired architecture of both the physical setting and its electronic counterpart.

2. Starting from Bricks and Mortar

Civil servants will move to MAC because the government needs to move, so a critical mass of a certain type will be there from day one. Some businesses will also move to capture the new opportunities. But what are the amenities that regular citizens and businesses demand in order to relocate?

We believe that both citizens and businesses want quality design, in the broader sense of the word: a design that addresses the entire spectrum of needs, from the most basic to the more aesthetic; a design that makes MAC distinct, an inviting place to be. This interdisciplinary design must be at a human scale. At a bricks and mortar level, it must include:

- dwellings that are pleasant and near to nature, in desired neighborhoods,
- exciting working spaces, often in a mixed-use setup
- inviting public spaces,
- easy and efficient transportation,

An implicit assumption is that land is scarce and high density is as necessary as it is politically correct. So, the artificial environment will dominate the natural, which makes the work of the designers far more complex and demanding.

The first three elements are static, while transportation centers on mobility. The static elements must be properly addressed, following the best practices of planning, urban design, and architecture, to make people feel comfortable and welcomed in their own city, while density and economy of resources are fundamental parameters in the design process.

Transportation is also crucial. The planners of MAC have followed a challenging way to create this new city-campus: a city of many cities built along a periphery, with the middle being low-density development and parks. This desired model in today's centrally congested cities requires an efficient transportation system to move people around and is fundamental to the success of the city. Public transportation and bicycles should be the preferred ways of moving around. Private cars and motorbikes should be completely eliminated from the city, with taxis, minivans, and personal vehicles on demand, like those researched by Prof. Mitchell at MIT, filling the need for customized transportation. Public transportation should operate at various speeds, with a fast underground system connecting the 23 neighborhoods of MAC. Trams and buses should provide transportation perpendicular to the main axis and in concentric circles to the subway system.

3. The Next Step: Ubiquitous Connectivity

Despite the unquestioned importance of the physical urban planning, we consider "ubiquitous connectivity" to be the key to making MAC a successful new city. It is the connecting tissue for the physical elements and, properly integrated, will be the single most important source of differentiation making MAC a desirable city to inhabit and visit.

Mark Weiser, the inventor of the ubiquitous computing concept, stated in 1993 that "ubiquitous computing is the method of enhancing computer use by making many computers available throughout the physical environment, but making them effectively invisible to the user." Several attempts have been made, some of them in Korea, at an urban scale. The most successful examples are given in other papers in this conference. It is worth noticing that it takes a joint effort to produce a meaningful approach to ubiquitous computing at the urban scale: on one hand, a conceptual designer with background in design, architecture, and urban design; and on the other hand, a telecommunications and computing expert. Approaching the problem should originate from both the design and the technology points of view.

Our proposal goes a step beyond the deployment of wired and wireless functionality to a new city. It proposes how this functionality will overlay and interact with the built, physical environment, and how it will enhance the lives of the citizens. The proposed virtual overlay is linked to the physical space and should be flexible and dynamic, to grow and transform as the needs of the people change, to be a living part, while the physical setting is more permanent. If the physical construct is the skeleton, the telecommunications infrastructure is the nerves and the veins, the virtual overlay is the muscles and the organs; it is what makes the city breathe and move, makes it be alive.

For the physical city, the urban designers and planners provide the master plan and then individual architects and contractors design and construct the separate buildings, roads, bridges, power stations, etc. In a similar manner, for the virtual city, the planning stage determines the requirements for the telecommunications infrastructure and its operations. The separate software applications, like the separate buildings, will be built and maintained by individual companies, serving the users and their needs. The proper design of the telecommunications infrastructure will support the bandwidth for such applications.

4. The Virtual Overlay

4.1 The Three Levels of the Virtual Overlay

The proposed virtual overlay on the city's fabric has three distinct levels:

- The basis for the virtual overlay is the physical telecommunications network infrastructure, comprised of the wiring, the wireless, together with any servers and routers required for operating the infrastructure. In a subway transportation analogy, this is equivalent to the tunnels, the tracks, and the control centers.

- The second layer constitutes applications that facilitate operations in the city, like traffic control, etc. Such applications will be provided by many vendors, using the provided infrastructure. In the subway transportation analogy, this is the trains.
- The third layer is the interface between the physical environment and the virtual overlay. In the subway transportation analogy, this is the stations and the interior of the trains, where people contact and experience the trains and the movement.

Our focus is on the third layer, the interface between the physical environment and the virtual overlay. While the most common interfaces are the personal computer and the mobile telephone, both have limitations that require a strategic and multifaceted approach to determine how and where the virtual overlay meets the physical environment to produce a ubiquitous city, a u-city.

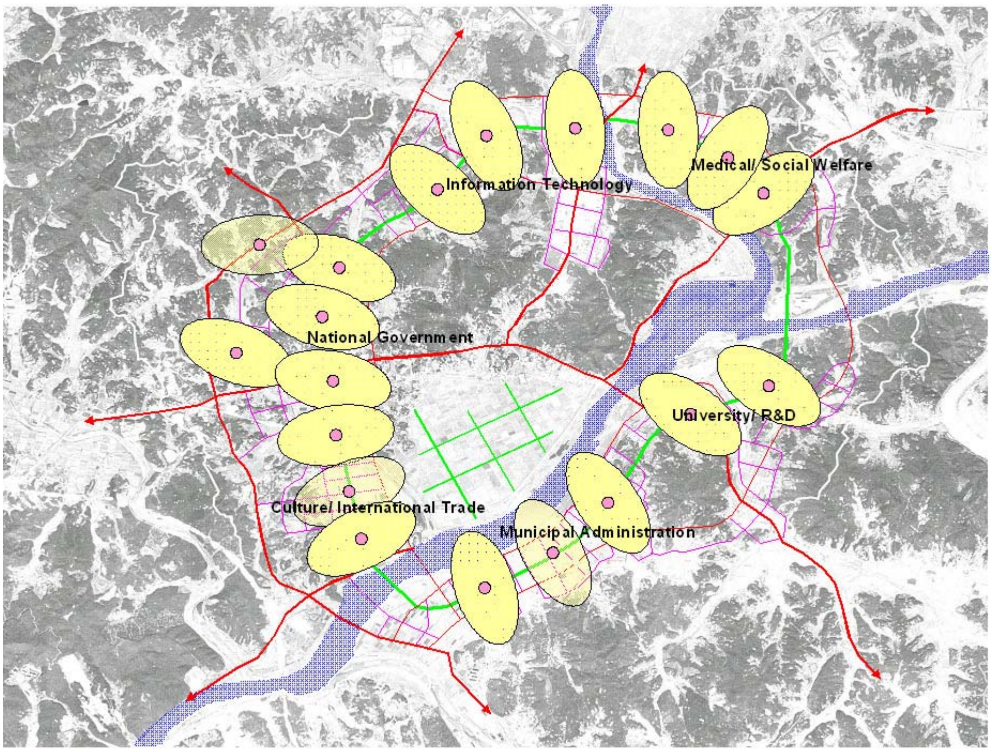


Fig. 1: *The virtual overlay will allow the development of MAC, a decentralized city with 6 centers and 23 communities (after Ortega's master plan).*

Personal computers are not fully mobile. Even laptops are heavy and cumbersome, with displays that do not function in bright sunlight. The answer is not to create cheaper and more powerful laptops to carry around but rather to reduce the laptop to its 3 basic components: input/output (I/O), processing, and data storage, and to distribute them across different locations and devices. Mobile telephones are fully mobile but are limited in terms of I/O capabilities, and they constitute one more piece to carry on.

Thus, our proposed concept is to enhance the physical environment with

- sensors and identifiers,
- distributed I/O devices,
- spaces suitable for I/O and communications.

At a first level of implementation, the sensors and identifiers can be mobile telephones, although eventually the identifiers should be embedded in wearable items, like watches, jewelry, clothes.

The innovative proposal is the incorporation of embedded I/O devices in the physical environment. The objective is to liberate the user from carrying large devices in order to connect; he/she will only carry an identifier, which will connect to the servers for the CPU and the I/O devices. Thus, the approach is to look at how the user will interface with the u-city and to facilitate such interface.

4.2. A user-centric approach towards the virtual overlay

Following ancient Greek philosophy, our approach is to focus on the user as the centerpiece of the new city, rather than start with the urban elements of the city. If we consider the user and his/her needs and expectations in the twenty-first century as an individual and as part of smaller and larger communities, the requirements for the urban and virtual elements derive in a more natural and meaningful way. As a second step, the approach focuses on the design of physical and virtual objects and systems, not just traditional city planning, as the new city will be made of “atoms” in addition to bricks and mortar. The approach is not to start with the design of a complete city, inviting people to come and inhabit it, which is quite unnatural. The approach is to provide a shell of both the physical and the virtual spaces and allow the city to grow as people walk in and make it their home; to allow it to take shape to fit their needs and their expectations.

This approach is anything but new. This is how cities have been built throughout the centuries. As a result, they have been plastic, adapting to needs and changing circumstances, making cities not perfectly planned, a little chaotic and perfectly human and livable. However, in today’s fast-paced world this is a luxury that we cannot afford in its entirety, as today’s new cities must be designed and start operating immediately.

Based on the user-centric approach, we envision the model shown in Fig. 3 as the proper way to achieve the u-city concept. It focuses on the three legs that support the u-city: the government and the services that the government requires, the needs of the users, and the technology to be implemented which determines what is feasible.

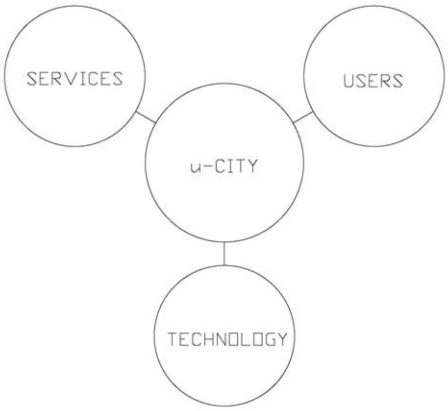


Fig. 2: *The proposed model.*

Each category includes specific functions:

GOVERNMENT AND PUBLIC SERVICES

- Information technology enhancing the city’s functionality in their everyday activities
- Transfer of information to people
- Reduction of transportation (within and to and from the administrative city)
- Public expression (art)
- Reduced use of physical facilities
- Connection to other cities
- Enhanced quality of life
- Security

USERS

- Supporting individuality
- Not carrying large communications devices, like laptops
- Easily accessible docking facilities for the light devices, such as the cell phones
- Access to information
- Continuous connectivity

TECHNOLOGY

- Network infrastructure
- Servers
- Software applications
- Physical facilities

4.3. Exposing and Automating Inefficiencies?

It is very common for people to think along the lines of the *Star Wars* films, where they use swords made of lasers for fighting. If such advanced technology were available, why make just swords and not more lethal laser weapons? The answer is that people can understand and sympathize with swords. A real laser weapon would be too advanced and too quick and probably not effective in capturing the laymen's imagination, and thus reduce sales at the box office.

We do not need ubiquitous computing to expose inefficiencies and automate ineffective processes. We would rather use ubiquitous computing to eliminate inefficiencies and design new processes of interaction. For example, instead of conveying the information across the city on the I/O or personal devices that someone is waiting for an individual who gets the message, the system should rather transmit information on where the individuals are and what the estimated times are for them to reach their common target point. Each party then optimizes their trajectory, so nobody waits.

Furthermore, the whole concept of meeting in person starts becoming obsolete in many cases. Why don't you meet on the fly? For example, if the system says to instructors and students that your class starts at a certain time, and there is traffic congestion, it makes sense to postpone (take action), as long as it is guaranteed that all parties are informed properly.

Furthermore, the privacy issue should be resolved when public I/O devices are used for communicating personal information. This is almost binary information that can be given with less media-rich devices, like private audio, or even the small screen of the cell phone, or even LCD glasses, with simple color codes to avoid distraction.

Displays embedded in the city fabric should project aggregate information and complex graphics that need decoding, and should allow high-quality communication, especially in the information pavilion, so someone does not need to go to an office to perform a function/transaction. They could alternatively do it from home or their private office, but the information pavilion offers the socializing and the ubiquitous dimensions.

A great example is the new key of the Toyota Prius, highly praised by consumers in the USA: it is enough to have it in your pocket; it opens the car on its own when you get close, it allows the driver to start the engine and then locks the car when you walk away. You do not need to take it out of your pocket. It is a key that has the functionality of a key but does not need to be handled as a traditional key. This is the kind of technology we need to portray.

5. The Digital Architecture

Not all ubiquitous activities happen at home, in private spaces, or via mobile devices alone. There is a need for physical public spaces with embedded communication elements throughout the city. These spaces are embodied in the form of Digital Architecture.

At first glance, ubiquitous connectivity seems to lie in the expertise of computer scientists and telecommunication experts. Wireless devices, manifested in cell phones and laptop computers, constitute the spectrum of connectivity. True, they are a necessary component of ubiquitous connectivity which, if properly implemented, can be a major step in making the city desirable. However, individual wireless devices, although powerful and convenient, have two limitations: first, they are individualistic, breaking the social fabric. Second, they are invisible in the urban context. Ubiquitous connectivity must be tangible, must have a visual presence in the city with an architectural face, so that people can relate to it; and, in turn, ubiquitous connectivity can have an impact on the city.

User interaction devices should be located throughout the city, in private and public spaces, linked to the wired and wireless networks. The installations in private spaces will depend on the individuals and private companies. The framework for the installations in public spaces will be governed by the objectives of the government to fulfill the scope of the ubiquitous city while being financially sustainable. The wireless interaction between the users and the installed interaction devices is a fundamental scope of this proposal.

Users will interface the u-city as individuals, small groups, and large crowds. As individuals they need privacy; as small groups they need semi-private open or closed dedicated spaces; as crowds they need large facilities, like squares, parks, and stadiums.

We identify four levels of Digital Architecture:

- the public interactive stations, spread through the entire city,
- the information pavilions, the nodes of the ubiquitous city in every neighborhood that connect the technology, the people, and the infrastructure,
- the Exploratorium, the main temple for information technology,
- public parks that blend nature with ubiquity

A fifth level is the wireless cloud that covers the city, anchored at the nodes and providing mobility and accessibility to all, anytime and at any part of the city. However, unlike the other four, the wireless cloud does not require physical spaces by itself, although it interacts with every one of the four levels of Digital Architecture.

5.1 Embedded Visual Output Devices

In a ubiquitous city, the public spaces and the exterior of buildings should have embedded visual output devices for individual and group interactions. Such screens can double as advertising boards and carriers of messages and information. The visual output devices should be both small size for individual and small groups and larger ones in spaces where crowds are expected to gather, such as subway stations, stadiums, and open spaces, to broadcast events of wide interest, like news, athletic events, etc. The spaces to house embedded devices should be properly designed to allow interaction when needed and allow the gathering of people without disturbing businesses and passersby.

There are already many cases of cities that have placed such devices in the public domain. Many of those address an artistic, non-information approach. Nevertheless, the architectural integration in the existing cases is often not fully worked out.

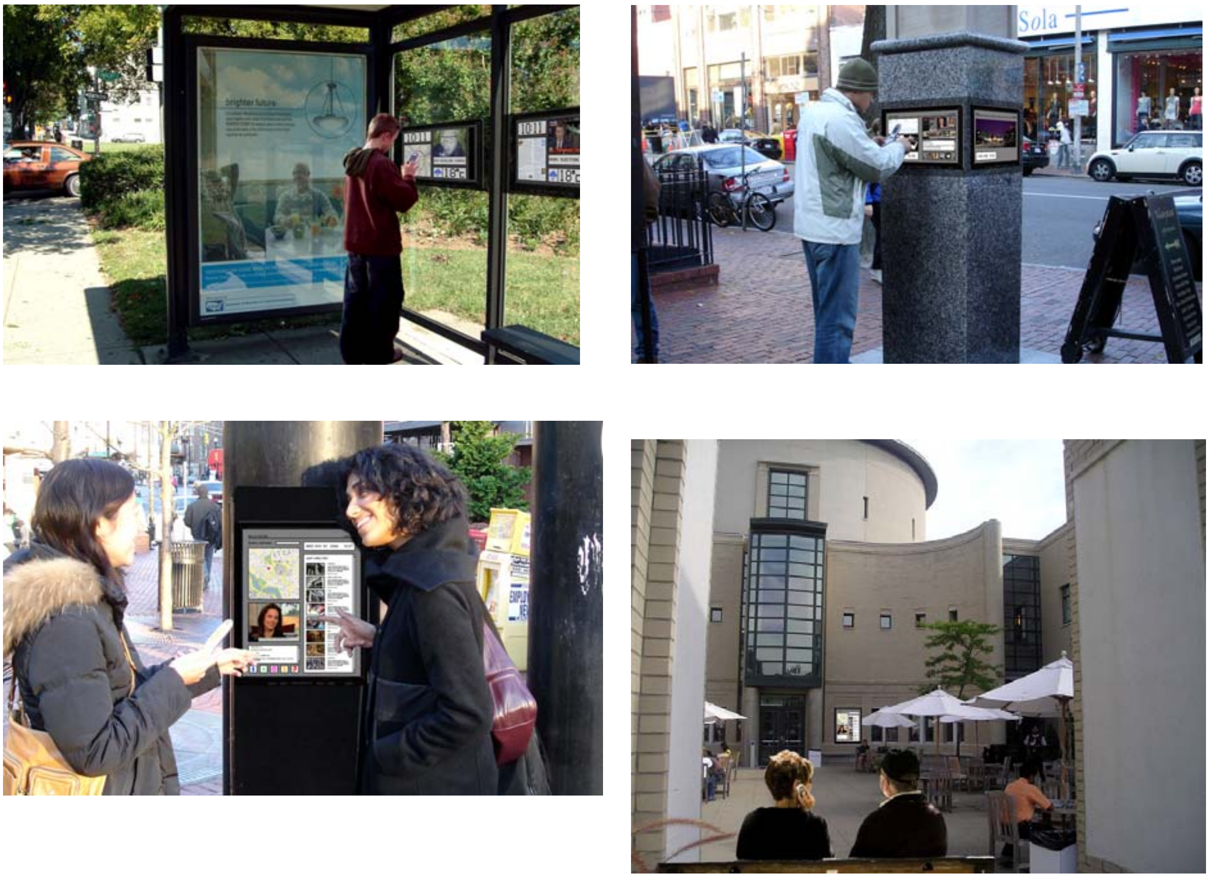


Fig. 3: *Embedded output visual displays in the city fabric (by Adam Modesitt, staged and photographed for this project).*

5.2. Information Pavilions

We introduce the concept of a series of information pavilions as a central concept to the u-city. The information pavilions are the nodes to act as centers of the u-activities, and it is proposed to have a pavilion in each of the 23 communities of the MAC. The pavilions are essential in each community. They are the modern day cathedrals in the square (piazza) of each satellite town. They serve as modern day libraries, newsstands, city hall meeting rooms, and public forums.

The information pavilions offer a shelter to the u-services and activities. Like any other activity in the city, u-services need their own architectural space, to be defined, have a presence, and also be protected. Most of the electronic devices are inside, under the monitoring of guards and assisting personnel but some are outside, in the courtyards of the pavilions.

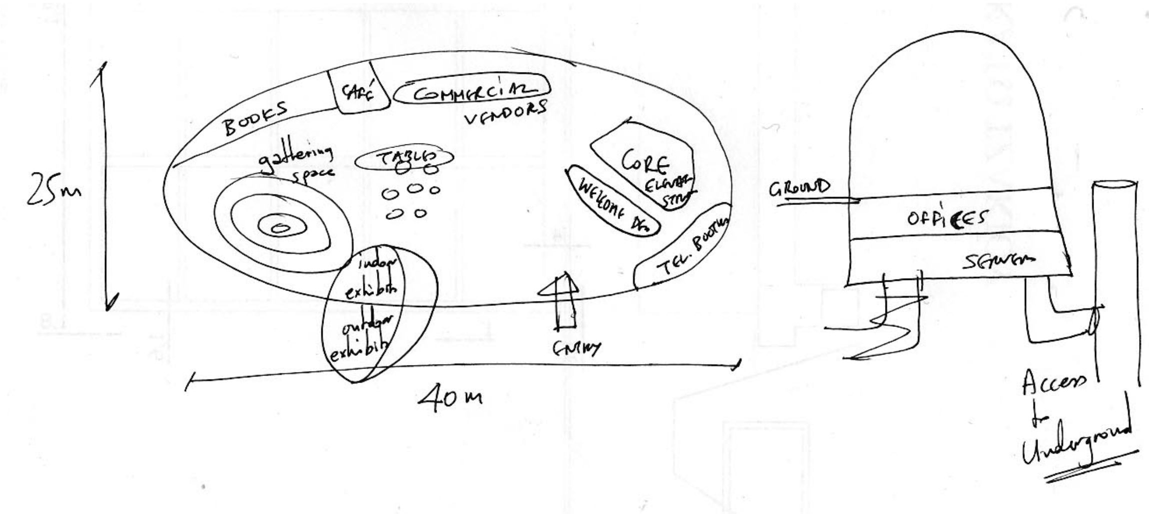


Fig. 4: *The sketch and program for the information pavilion.*

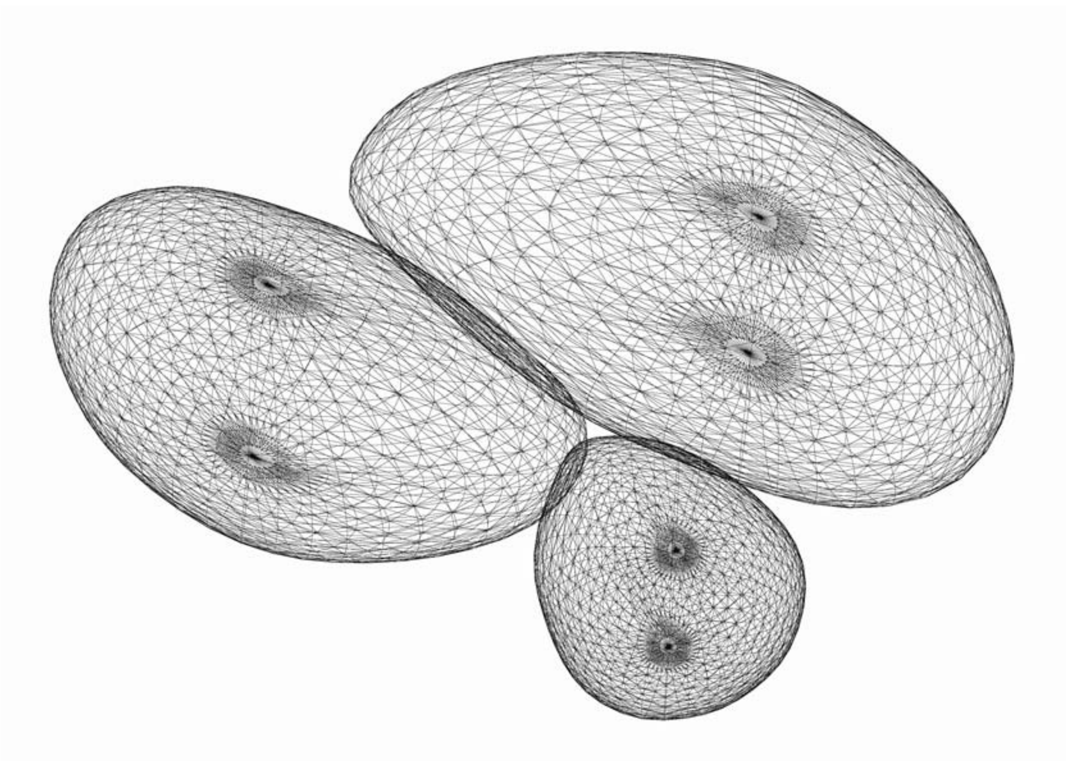


Fig. 5: *Early concepts for an information pavilion (by Prof. Wooyoung Kimm).*

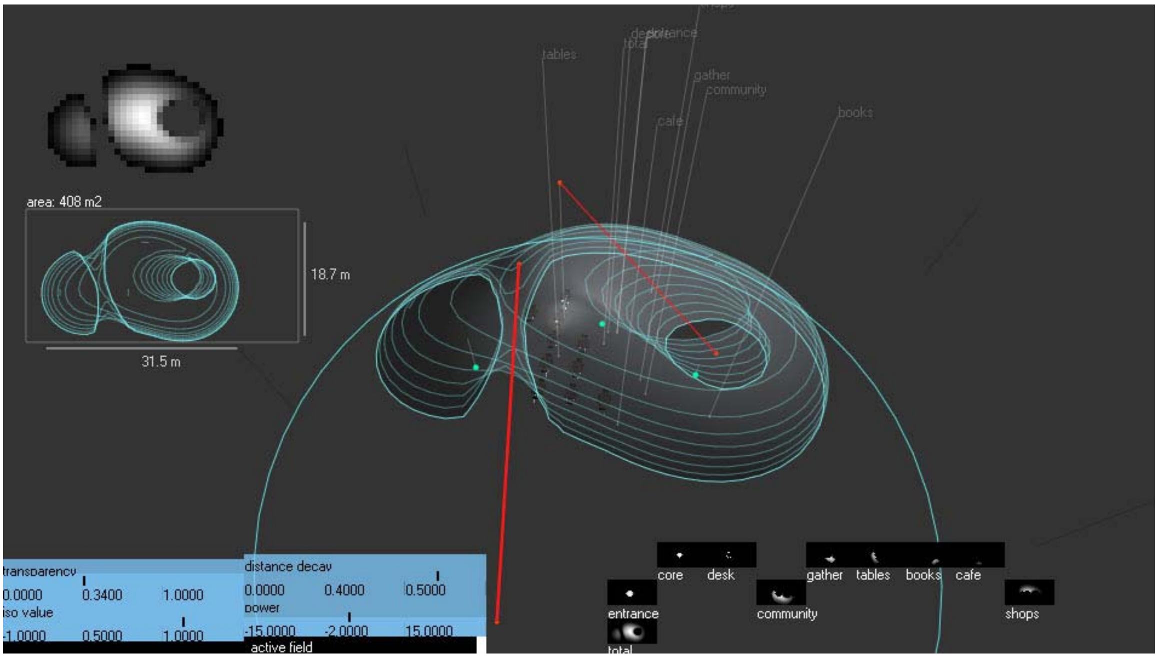


Fig. 6: *The parametric generation of an information pavilion (program in C++ by Panajotis Mihalatos developed for this project).*

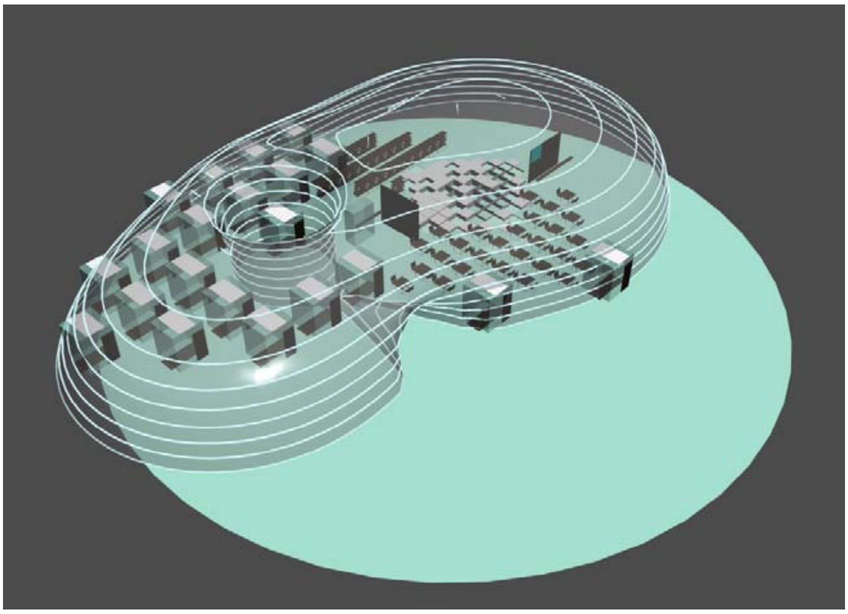


Fig. 7: *A parametrically designed information pavilion (by Panajotis Mihalatos developed for this project).*

The outside space is inviting and has places to sit and relax. Inside, on the ground floor, they have a large open space, full with display devices, book racks, sitting areas, and desks for the staff. The ceiling is domed, to reflect the curving of rays and the universe, while the flooring is uneven, to create spaces for interaction and privacy. In addition to the large open space, there are private spaces like telephone booths for individual communications, open booths for interacting with the internet and the city, as well as large rooms, the equivalent of reading rooms. In addition, the information pavilions have spaces to be used as open classrooms, when schoolchildren visit the MAC.

The information pavilions have 2 floors below ground for offices and computer equipment. All the services, including restrooms (except for an accessible restroom) and vending machines are in the lower floor (basement), so that there is a purity of form of the single story upper floor. Light wells bring natural light to the floors below around the perimeter. They also serve as the entry points to the underground infrastructure. There is access through the lower basement, while a full diameter tube is in the courtyard to the pavilion, in the open air, accessible to cranes and trucks.

The 23 information pavilions have common characteristics, they belong to the same family of design but they are different. A typical pavilion was conceptually designed to fit the scope of the building. This design led us to the shape shown in Fig. *.   Then, the other 22 pavilions have been designed parametrically, to be similar to each other but distinct, each one of them having its own character.

Our proposal for the parametric generation of the pavilions consists of 3 positive nodes that form the body of the pavilion and two negative line segments that form the atrium and the entrance tunnel respectively. The program is generic and can add and remove elements if needed to make more or less complicated shapes, it can read and write xml files. It shows a floor plan with basic dimensions and an estimate for the floor area. The mesh of the roof is extracted in real time, and further layers of detail can be added as required.

A partition algorithm for the floor boundary, based on a hierarchy of nested functional areas, distributes the various uses in the upper floor. The areas are shown as icons in the bottom right of the screen. The algorithm assigns the percentage of each area requested for every function. Then objects like shops, tables, bookshelves etc. are distributed in these areas. Initially all elements have the same orientation and are very orthogonal, juxtaposed to the fluid overall form and the pixilated distribution of elements within the space, but they can also be flexible, facing in different directions and with variable sizes and shapes aligned perhaps with the field that generates the overall shape.

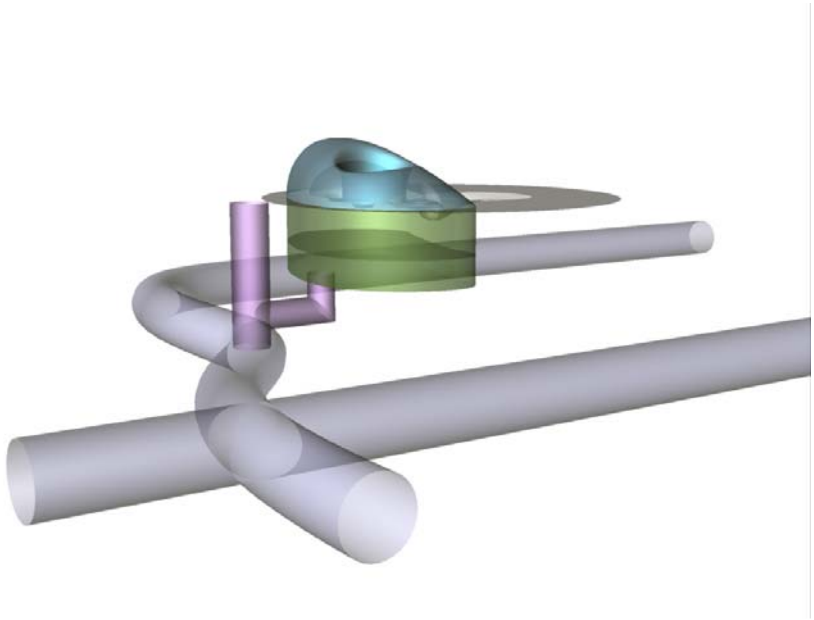


Fig. 8: *Each information pavilion serves as an entry to the underground infrastructure of conduits (by Kirsten Hively, developed for this project).*

The completeness of having a computer-based generator of form to serve as the node of the u-city and a shelter for ubiquity creates a powerful platform to interchange the process and the product at a conceptual level.

5.3 Exploratorium

The impetus for creating the Exploratorium was the control center, a central concept of the MAC's technological infrastructure. A large space to monitor and control the communications and the network, it is the heart of the entire system and a piece worth exposing to the public view. The second point of departure was a desire to have a museum for information technology.

In addition, the MAC needs a symbol. Visitors should have a place to go, to photograph, to identify both with the ubiquity of MAC and with its physical construct. Thus, we propose that a complex at the visual center of the city will serve that role. We envision it as a "mega-pavilion," consistent with the architectural language of the information pavilions but much bigger in size, with each of the two buildings of the complex having 15-20 times the floor area of each pavilion. Our proposal consists of a lower building that serves as the main public building, and a tower.

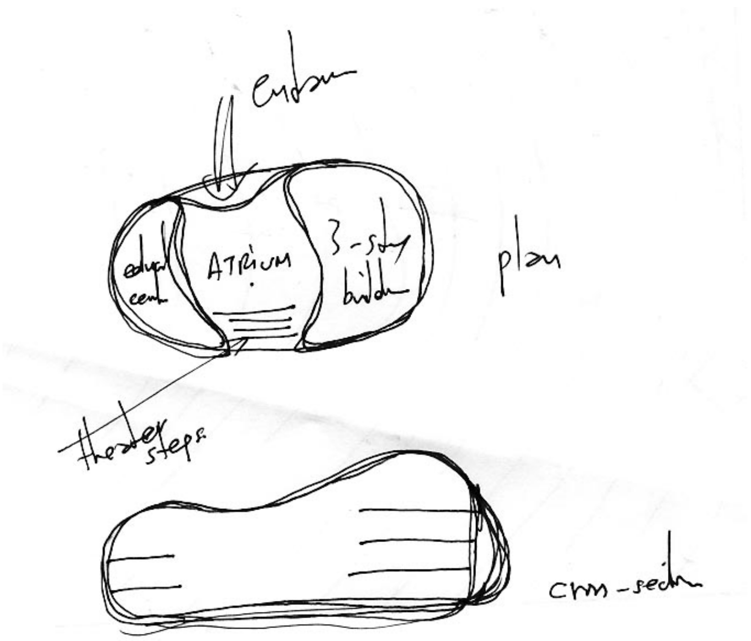


Fig. 9: *The sketch and program for the lower building of the Exploratorium.*

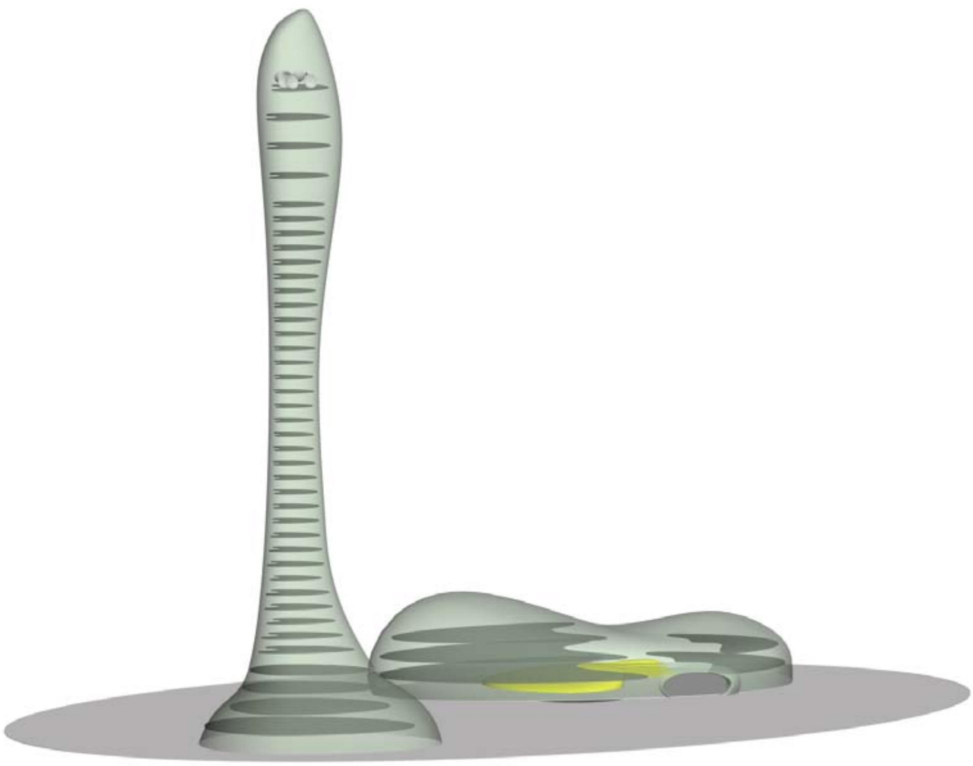


Fig. 10: *The Exploratorium: high and low rise buildings (by Dimitris Papadopoulos, designed for this project).*

Because of its intended function, we call these buildings “Exploratorium,” the buildings to explore information technology at large, information technology as has been implemented in the MAC and the potential of information technology in the future.

Visitors enter a covered atrium in the lower level building and there is an open amphitheater across the entry hall, exhibition spaces on the left and educational spaces on the right. The Exploratorium serves as the genesis of a new era, thus its footprint has the form of an egg. The control center of all the wired and wireless activities in MAC is at the top basement of the building, under the atrium. Visitors see the screens through glass walls, at a distance, but cannot see the operators who sit under the floor of the atrium.

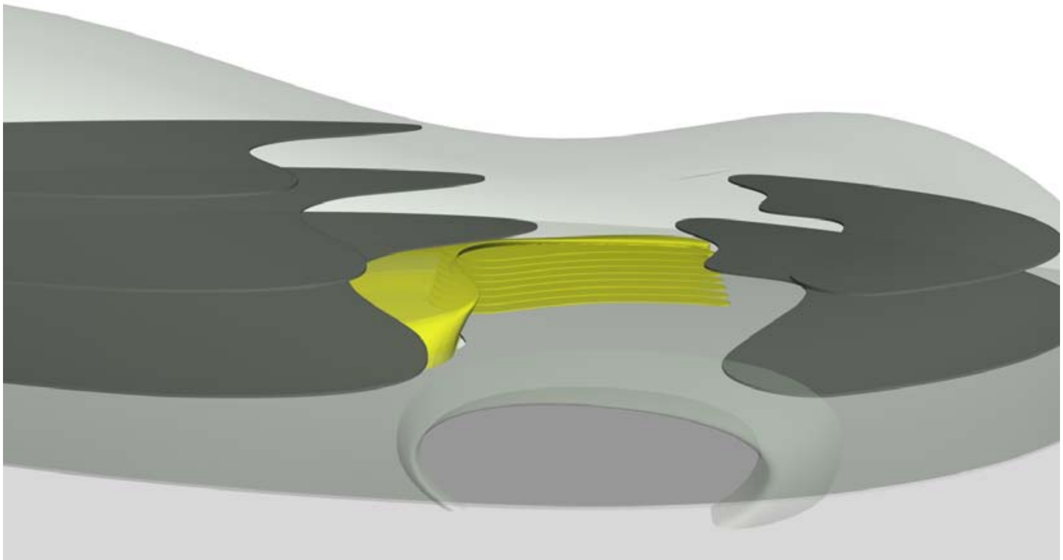


Fig. 11: *The atrium, open amphitheater, and the control center (by Dimitris Papadopoulos).*

The Exploratorium includes an exhibition space of information technology, aiming to serve as a museum on the history of information technology, a museum on privacy, and a platform for the new applications to come. It is expected to be the single most important destination of visitors to the new city and the place to be in the entire country for information technology related issues. It will be a central node in the process of deploying information technology in the city.

The education spaces include a large amphitheater, working exhibits, teaching modules, etc. They are primarily focused on children visiting the Exploratorium, although the facilities may be used for other functions as well.

The entire 2 basements of the museum will be used to house the servers and the equipment needed for the control center.

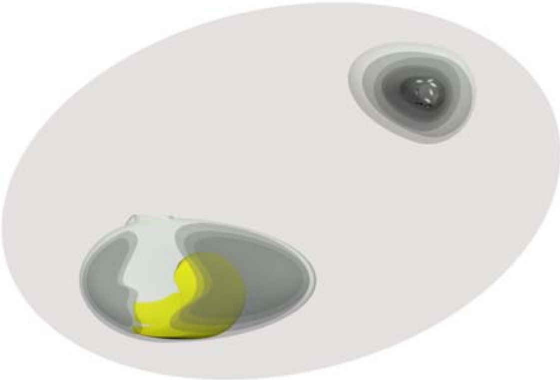
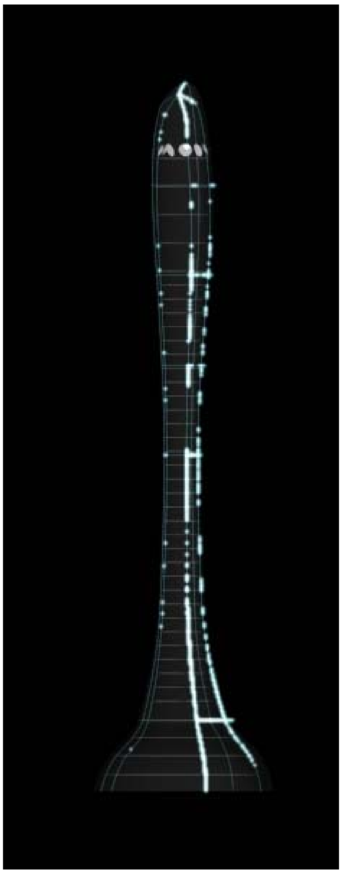


Fig. 12: *A plan of the 2 buildings showing the atrium, the open amphitheater, and the control center at the low rise building and the antennas on the high rise building (by Dimitris Papadopoulos).*

Fig. 13: *A side view showing the 2 buildings of the Exploratorium. The control center is shown in yellow (by Dimitris Papadopoulos).*



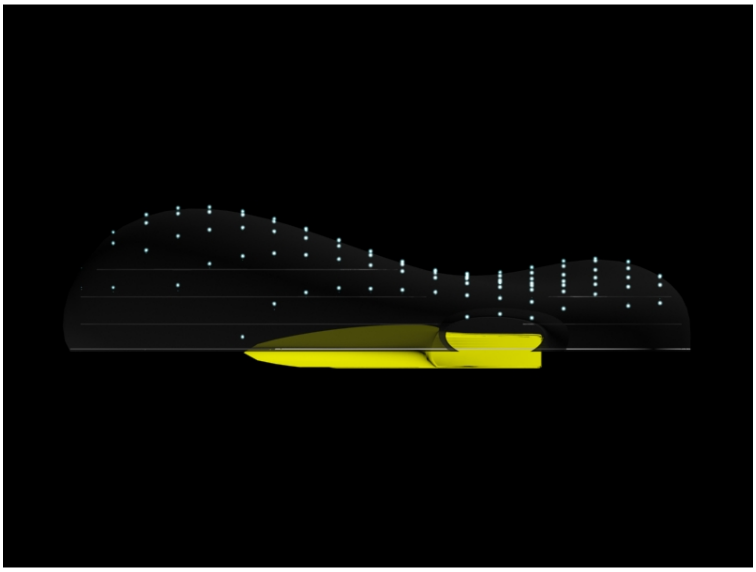


Fig. 15: *The Exploratorium illuminated at night (by Dimitris Papadopoulos).*

Fig. 14: *A simulation of the interior exhibition spaces (by Prof. Wooyoung Kimm).*

The tower is located next to the low rise building. Its shape juxtaposes and complements the low rise building and houses the offices of the Exploratorium, and a series of antennas on the very top. It will also include private offices and residences, a food court in its base and an observatory platform on the top, just under the antennas. Its main purpose is to have a tall symbol for the city and to generate income through commercial and residential leases. Both the tower and the lower building will have lighted surfaces to glow different colors, transforming themselves and the city at the different levels of natural light.

5.4 Large Gathering Spaces

The design of parks and large gathering spaces is a major component in the design of the u-city. The concept and a proposal for such spaces have been presented in the PARK concept, *Space* magazine, in May 2005 by Pollalis et al.

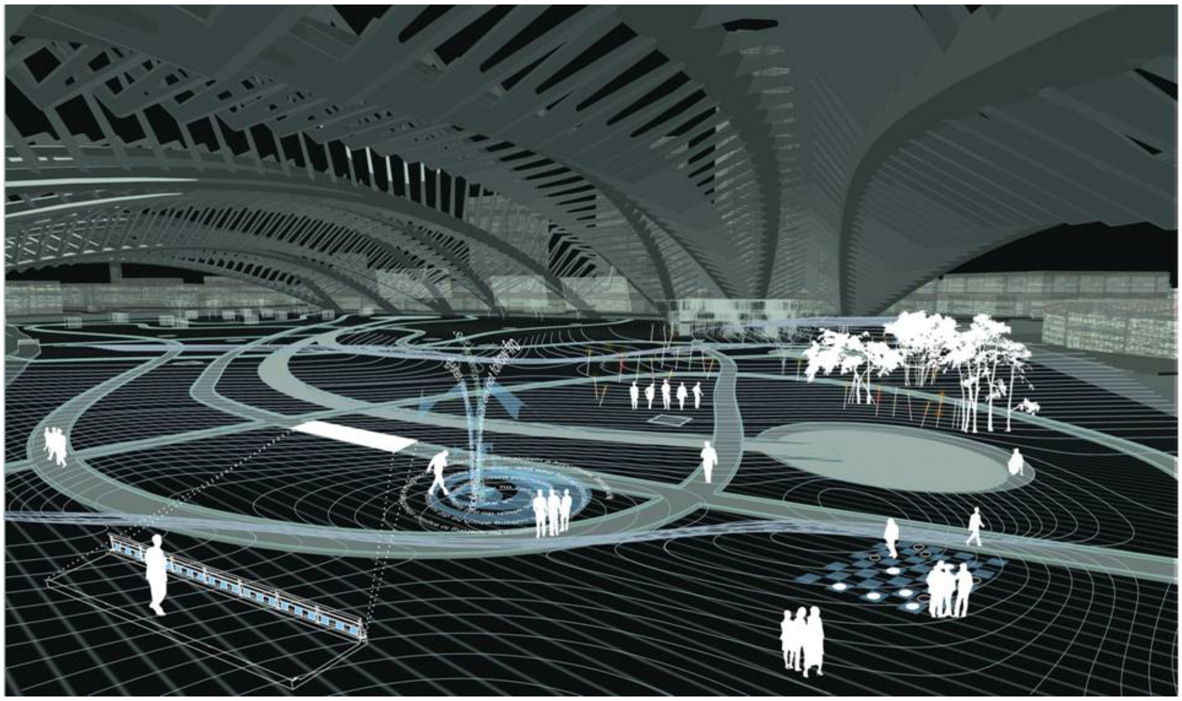


Fig. 16: *The interior of PARK (after Pollalis et al., Space, May 2005).*

5. Design of the Infrastructure, Non-visible Part

It is proposed that the entire network of the new city will be located underground in conduits, easily accessible for maintenance and updating (Fig. 4). Separate conduits, to be installed during the initial construction phase, will be provided to third parties. It would be desirable for the conduits to be part of the larger utilities infrastructure, including electric power, water, sewage, and gas, similarly to how these have been installed in Shanghai and shown in the Shanghai city museum (Fig. 5).

However, in addition to providing the option of conduits and transmission towers for the larger third-party providers, bandwidth service will be available through the installed cabling and the wireless infrastructure. By separating the security-sensitive data from third-party applications using virtual private networks (VPN) technology, it will allow the growth of smaller companies, especially in developing applications, and will enhance the city's effectiveness in becoming ubiquitous.

Fig. 17: *A large conduit for carrying the city's services in an organized way (Shanghai City Museum).*

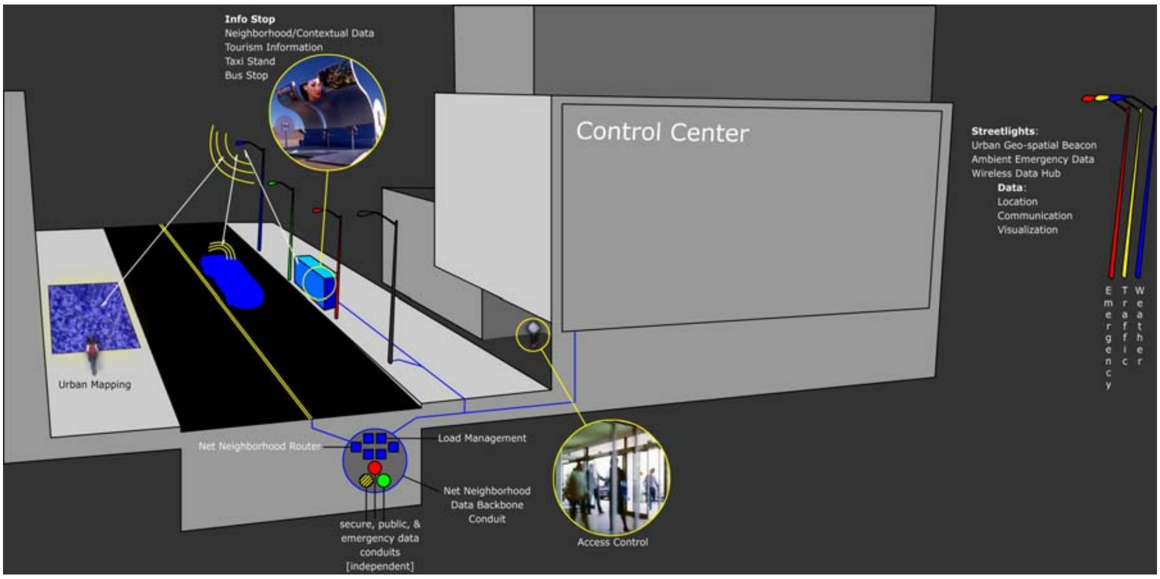


Fig. 18: *The underground urban infrastructure (after Scott Pobiner, developed for this project).*

6. Sustainable Design

Without any doubt, the design of the new administrative city must be environmentally sustainable. Such a goal will be achieved by the urban designers and the architects following the specifications of the government.

The ubiquitous layer adds a much-needed dimension to the environmentally sustainable design. Virtual applications do not consume natural resources to build, and they often substitute for the use of natural resources during operations. A classic example is virtual games. Not only are virtual games made digitally, but they also consume only electricity and no material during operation. No space is needed in dumpsters or landfills when new versions are available, or when repairs are needed.

Thus, by proposing a large, flexible, adapting, virtual overlay on top of the city, we reduce the consumption and recycling of physical materials that would have been required to update the equivalent physical spaces. We also reduce transportation and the need for physical space, as the use of space is intensified.

7. Business Plan

The fundamental concept in the business plan, "how to sustain the proposed ubiquitous city," is through the offering of new services not seen before that will generate economic activity.

Information technology is always first introduced as a substitute technology: it replaces processes that were done manually, or semi-manually, with automatic processes that are more efficient, costing less. However, almost universally, information technology adds new functionality in ways that were unthinkable before, opens new frontiers, and reestablishes the way we live, work, learn, play. Through this ever-repeating process, new activities and markets develop that generate economic activity that is difficult to predict in advance.

It is precisely on this feature of information technology, the economic generation in every step of the process, that we base our proposal. The step towards the ubiquitous city is financially substantial and will be manifested in 2 ways:

- It will make the city more desirable to live and work in.

- It will allow activities that will not be available elsewhere in the country.

In this scheme, the ubiquitous city overlay will generate revenue to pay for itself from multiple sources:

1. Because of the efficiency of economic transactions, a small fee can be assessed on each transaction at source.
2. Advertising will always be a preferred method of generating revenue.
3. Users will be charged to have access to enhanced functionality for getting through the city and accessing public resources, recreation, and education.
4. As the success of the ubiquitous city will draw residents beyond the planned numbers, an additional small taxation will not only generate revenue but will also help to reach equilibrium between visitors and residents.
5. It is expected that the ubiquitous city will attract visitors, from within Korea and from abroad, who will need to get access to the new services by paying a small daily or weekly fee.