A Place-Theoretical Framework for the Development of IT in Urban Spaces

Volume I

by

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Abstract

The following thesis is an attempt to develop some analytic resources for thinking about problems and possibilities arising from the incorporation of Information Technology (IT) into the design of public spaces, especially in the early stages of design process. The main concern is about how to deploy digital technologies components, such as microprocessors, sensors and actuators in order to positively affect various qualities of place. The framework developed in the thesis begins with an analysis of public places, and then proceeds to an identification of the spatial conflicts that impair *qualities of place* such as *territoriality, privacy, identity* and *ambience*. Components of IT were then spatially correlated to those qualities, thus revealing how these might be potentially applied as part of a system that would combine IT with spatial/physical solutions. The thesis focuses in particular on the development of the framework, which is traced by the close examination and scrutiny of three situations in which the design of public places was supported by this theoretical approach. The projects that arose from these are studied as *case studies* with the aim of determining the efficiency of the framework as a tool, and amendments to the framework were made in light of the necessity to clarify how the deployment of components of IT as part of an integrated design solution with place attributes might be justified. Finally, the thesis demonstrates that the analysis of the individual cases leads to the conclusion that the use of the developed framework is able to provide a basis for a coherent set of decisions regarding the application of IT in public places. In addition, possible ways in which the approach described might be improved and ideas for future research are suggested.

Introduction

Introduction

This thesis aims to provide a theoretical support for designing for the use of Information Technology (IT) in urban spaces. It is concerned with supporting architects in the creation of design solutions that bring together both physical interventions and digital technologies components. Digital technologies components are the electronic devices, such as microprocessors, sensors, electronic tags, servomechanisms and other items that can integrate complete systems of computing resources. When those components are spatially scattered across the built environment and, at the same time, functionally integrated with the local activities, they come to constitute a Ubiquitous Computing system (Ubicomp). Those systems use quotidian objects and spaces in the environment as interfaces to people accessing the computing resources. Thus, from an architectural point of view, this thesis will be concerned with the design of Ubicomp systems that can invigorate and strengthen the qualities of public urban spaces where they are applied.

The term *Ubiquitous Computing*, first coined almost fifteen years ago by Mark Weiser (1993), a researcher at the Xerox Palo Alto Research Centre, was used to signify the vast range of technologies that allow computing to be brought into the actual world where people are living and working (Shafer, Steven and Nolan 2000). Weiser believed that desktop computers would disappear as the tiny and cheap microprocessors that powered them faded into the built environment. In other words, on this point of view, computation will eventually become intertwined with everyday life. '*Ubiquitous*', in this sense, means not merely '*in everyplace*' but also '*in every thing*'. Ordinary objects and spaces would act as sites for gathering and processing data, and people would interact with these systems fluently and naturally, barely noticing the powerful informatics they were engaging.

The idea of Mark Weiser can be regarded as the first explicit, technically articulated formulation of post-PC era ubiquity, but it was not the first one. Before him, Negroponte has started his investigation about the possibilities of using IT in the environment. In his books '*Soft Architecture Machine*' (Negroponte 1975) and, later, '*Being Digital*'(Negroponte 1995), and also in many other articles published since 1993 in '*Wired*' (see http://web.media. mit.edu/~nicholas/Wired/), introduced his concerns about the use of IT towards a responsive environment, suggesting that the design process could be presented to a machine considered evolutionary as to give mutual training resilience and growth. Simultaneously, Professor Hiroshi Ishii, at the MIT Media Lab, was developing the project '*Things That Think*', extending computing into domestic objects and spaces (Greenfield 2006). Ever since the development of mobile technology and sufficiently powerful phones started, they began to become '*connected*' computing devices, offering other services beyond the means of simple conversation. Intriguingly, the various research centres and companies involved in the development of technology applied in ubiquitous ways did not understand the field in the same way: research split into a wide variety of branches, with some focusing on the development of networking technology, and others on microcontrollers, new connection protocols, radio-frequency identification and so on.

Regarding a definition of '*ubiquitous*' in the context of this research, it would seem to be a difficult task to contemplate the vast range of contributions on the subject fairly and adequately. In fact, since Mark Weiser's initial conception of the idea, the proliferation of themes related to ubiquitous makes it impossible to make any attempt to come up with a concise formulation. But this is not the only problem: the speed with which discussion of this subject has spread through conferences, seminars and workshops has created a contemporary intellectual climate that is very difficult to follow. Exemplifying this, Adam Greenfield (2006) mentions that by the time he started doing the research which led to his book "*Everyware: the Dawning Age of Ubiquitous Computing*", the literature on ubiquitous computing was "*a daily tide of press releases and new papers that was difficult to stay on top of: papers on wearable computing, augmented reality, locative media, near-field communication, body-area networking*" (Greenfield 2006, pg 13). In many cases, he observed that the fields were so new that the technical terminology and jargon had not even yet solidified. However, despite the richness of the variety of publications on the subject, few of them in fact address the issue of the '*spatiality*' of Information and the '*spatiality*' of its technology.

The idea that was firstly conceived by Mark Weiser 15 years ago cannot exactly be recognized in the contemporary discussion of the application of computing resources to objects and the environment. This means that many examples of '*ubiquitous computing*' that exist nowadays are, in their own different ways, attempts to grasp a language of interaction suited to a world where information processing would be omnipresent in the human environment. Greenfield (2006) suggested calling this debate about ubiquity the discussion of the ecology of devices and platforms which have computing capabilities. Thus, quoting his idea in the context of this research, *Ubicomp* can here be appropriately taken to mean the principles and elements of *the ecology of the information supported by technology in public spaces.*

This following introductory discussion will focus firstly on the importance of the participation of architects and urban designers in the design of ubiquitous computing - *Ubicomp*. Afterwards, attention will move on to some examples of Ubicomp applied in the urban scene, in the form of a short chronological study. Once this context is depicted, a real project of urban recasting using IT will be described as the starting point that originates the key research questions. Thus, a discussion of those key questions will follow, justifying the importance of developing a framework addressed the field of architecture.

The research context

The widespread use of Information Technology nowadays has changed the way people deal with space itself. The use of communications and the representation of that usage have introduced people to new means of interaction and socialization. The relation of that socialization to space has dramatically changed from what was known years before. Firstly, it was imagined that *Virtual Reality* - the electronic representation of space in which people can interact and communicate - would shorten distances thus threatening to make actual physical space itself useless. Now, the widespread of communication devices within the environment is changing once again the importance of space. The use of wireless devices has introduced new possibilities together with the use of moveable devices endowed with computing capabilities. At the same time, physical space has started to lodge electronic gadgets and embedded computing devices which can sense modifications, process information and actuate interactively with people in the space. All those resources can be explored by architects and urban designers in projects that include environmental

computing capabilities. Those new IT possibilities started to challenge those professionals to take into consideration a wider range of variables related to spatial situations in the place concerned whilst seeking for architectural solutions.

For example, activities can now be scrutinized more accurately in terms of types of users, frequencies of usage, origins and destinies, preferences, special needs, and so on. Such information can trigger different arrangements of spatial elements and equipment in the space concerned, helping to provide quick changes in the environment in order to reduce energy wastage, to promote more security within the activities, or simply to improve user satisfaction. The fallibility of equipment and the breakdown of spatial elements can also be automatically monitored in order to trigger immediate reactions, thus avoiding disruption to activities. Therefore, a new level of interactivity is becoming a very real possibility, with many potential applications for the use of computational resources in the field of architectural creativity and problem solving.

However, the design of the use of IT in urban projects is problematic where it concerns architects and urban designers. As was recently pointed out by Malcolm McCullough (2004), those professionals need to become aware of the challenges and opportunities raised by ubiquitous computing, and they need to be discerning when it comes to the spurious terminology that has spread across this field. For ubiquitous computing, the architecture of physical places is the context that supports its application. However, as with many other words in the field, the term '*ubiquity*' has become overexposed. '*Ubiquitous Computing*' has quickly come to mean just about anything having to do with universal connectivity. Consequently, the *universalist* understanding of that term overlooks the value of architectural contexts. Thus, the importance of the real space has been seen to have become of reduced importance, and architects and urban designers have been conditioned into an outlook that continues to marginalize the new operations and requirements that IT brings to the built environment. Also, '*techno-futuristic*' waves of enthusiasm have created many lame metaphors for IT pervasiveness, for instance, the idea related to the *anytime-anywhere* uniformity of services resulting from ubiquitous computing. Since those metaphors have been outmoded, architects can contribute to the evolution of the field through research into new approaches that allow for the inclusion of located peculiarities without detracting from physical characteristics and user requirements.

The call for the participation of architects in the discussion of ubiquitous computing came up during the last few decades and from many authors. Regarding architecture as an interface between place and information, Pawley (Weiser 1993; Grahan, 1998) appealed to architects for a new way of applying IT in architectural and urban projects, focusing on the real interactions required by people's activities. Taking the same perspective, Shafer (1998) stated that the search for an IT design process that considers meaningful interactions with people and places is the central problem preoccupying this emerging field of research. Similarly, Sengers (2004) argues that the design of IT solutions for urban areas requires an understanding of spatial and social organization in order to incorporate the meanings engaged, but most discussions about that, however, either rely on engineering perspectives, focusing on hardware discussions, or on the perspectives of the '*Digital Arts*' (e.g., Novak 1996; 2000; Oosterhuis 2002).

Recognizing the difficulty of integrating IT with urban design, Eamon O'Neil (2004) stated that to build systems that use IT in cities, "*we have no fundamental theory, knowledge base, principle methods or tools for designing and building ubiquitous computing systems as integral elements of the urban landscape.*" He has claimed to extend and adapt the understanding and practice of both urban design and IT design solutions through new research works. A systematic approach to IT design in the urban environment, such as an integrated system of physical architecture and IT technology, demands an amalgamation of the disciplines of architecture, urbanism and computer science. But the key to this interdisciplinary integration is the concept of space, not only in terms of physical location or volume but also taking into social phenomena, and the conventions and values attached to a particular physical space.

In the course of arguing for increased co-operation among all the fields involved, Adam Greenfield and Mark Shepard (Greenfield and Shepard 2007) observed a reduction in the autonomy of the Architectural field specifically focused on the discussion of Ubicomp. According to them, users' participation promoted by the technology poses some questions regarding the privileged position of architects as the unique interpreters of users' wishes and behaviour. Participatory skills represent a way of understanding the real dynamism of life in public places. At the same time, this situation points to an opportunity to research frameworks aimed at conjugating all the possibilities raised by both the participation of users and the fields involved in the solutions. However, they recognized that "*there is a lack of expertise in this area, although this may be attributed as much to the relative "newness" of the territory as to existing disciplinary boundaries* (Greenfield and Shepard 2007: 34)."

Predictions for the future of IT (Weiser 1993) prognosticate that its use in urban refurbishments could reduce costs, being an alternative to the traditional processes of urban recasting. IT 'widgets' could minimize the physical inconveniences that go alongside urban reform, providing easy installation, adaptability to the dynamism of urban life, and the fine-tuning of components and effectiveness. However, all those predictions are still far from what we see in the present, and much more research needs to be carried out in the field. Mark Weiser commented in 1993 that few places in the world had begun to work on IT use in the urban scene at that time, and the scene today is not much different.

Since the late 1990's, several groups have begun to develop emerging computer technologies in several disciplines, dealing with geography, space, location, and the built environment. In brief chronological order (Chalmers 2006), they are:

- *The Mobile Augmented Reality Systems* (USA, Columbia University, since 1996) researches user's interactions in a synthesized world overlaying the real world in the representation of useful information about reality (Augmented Reality). The group's research projects include, additionally, small and inexpensive computing devices networked such as mobiles. They have focused on the identification of generic tasks that users would want to carry out using such contextual computing systems (see http://www1.cs.columbia.edu/graphics/projects/mars/mars.html to further details).

- *The Centre for Advanced Spatial Analysis* (UK, University College London, since 1998) provides expertise in IT based spatial decision systems and spatial analysis, connected to UCL and promoting a continuous debate in the field. Within the Centre, expertise is drawn from archaeology, architecture, cartography, computer science, environmental science, geography, planning, remote sensing, and transport studies (see http://www.casa.ucl.ac.uk/news/index.htm for more details).

- *M-cult* (Helsinki, Finland, since 2000) is a publication dealing with urban and participatory media, wireless media culture, and other related topics (see http://www.m-cult.org/index_en.html).

- *The Intelligent Inhabited Environments Group* (UK, University of Essex, since 2001) is involved in developing methods to enable non-technical end-users to harness the potential of pervasive computing systems in their everyday lives, creating intelligent and interactive environments (see http://cswww.essex.ac.uk/Research/iieg/index.htm to further details).

- *The UK Computing Research Committee* (since 2002) which started stimulating groups of different institutions who address technical, social and design issues in the development of new inter-relationships between the physical and digital. This Committee plays a fundamental role in the field, gathering and publishing results of research works, being an

important source of information about state of the art IT usage in urban places (see http://www.ukcrc.org.uk/about/index.cfm);

- *The Future Physical Group* (UK, Shinkansen Arts Group and Arts Council England, London, 2002-2003) explores interactivity in the use of digital technologies to enhance a broad and diverse number of experiments, including bio-technology, wearable computing and eco-technology (see http://www.futurephysical.org/pages/fphome.html);

- *The Mobile Technologies Group* (USA, Georgia Institute of Technology, since 2004) explores the social impact of current and next-generation mobile technologies, expanding the applications for these technologies (see http://mtg.lcc.gatech.edu/);

- *The Urban Design and Pervasive Systems - Cityware* (UK, since 2005) is a research project that focuses on the design and implementation of city-scale ubiquitous systems as integral facets of urban design, studying and evaluating those systems and their relationships with urban space and society. The goal of Cityware is to develop theory, principles, tools and techniques for the design, implementation and evaluation of Ubicomp in urban spaces (see http://www.cityware.org.uk/ to more details).

- The *Architecture and Situated Technologies* symposium (US, 2006) was organized by Omar Khan, Trebor Scholz, and Mark Shepard, being a co-production of the Centre for Virtual Architecture, The Institute for Distributed Creativity, and the Architectural League of New York. The symposium sought to occupy the imaginary of emerging technologies in Ubicomp and propose alternate trajectories for their development. Through a combination of presentations, discussions, and performative design scenarios organized around the notion of an "encounter" with the city, the symposium explored how architecture might contribute to the development of situated technologies, and how a critical engagement with these technologies might extend architecture beyond itself. (see http://situatedtechnologies.net to further information)

- *Living City Project*, (US 2007-2008) by Van Alen Institute New York Prize Fellows is informed by the research works of David Benjamin and Soo-in Yang. Focusing on the role of the individual buildings, the project is concerned with developing an interface through which each building can integrate a web of information for controlling all resources required for their maintenance and limiting waste of energy and the like. Many other experiments concerning the integration of buildings with public space are focused on in this project, resulting in prototypes such as the '*Living Glass*', which permits the interactive exchange of carbon dioxide gas in facades. The group planned to bring out the developed platform of the '*Living City*' software by January of 2008 (see http://www. thelivingcity.net/ index.html to more details).

Also in 2006, The UK Computing Research Committee issued a '*Ubicomp Manifesto*' (O'Neil 2006) intending to ordain this field of research themes. But, as mentioned previously, according to that manifesto, the central questions about IT usage in the urban sphere are still considered open and the research works about physical urban space improvements by means of IT widgets are still scarce.

After observing the context depicted above, the research context of this project can be introduced as comprehending the recent investigations into IT applied to urban spaces. But, on the other hand, the concept of '*place*' and '*space*' integrates that context as well, since those concepts are commonly used in studies of IT applied to the built environment. They acquired different meanings via the insights of diverse theories, and they need to be revised in order to make them understandable to both architects and IT engineers (Graham 1998: 167).

The initial situation and key questions

The initial reasoning behind this research was occasioned by the International Idea Competition on Urban Design *"Revitalization of Gwangbok Street and PIFF Plaza"* at Busan city, South Korea, 2005 (Souza, Renato C. F. and Kim 2005). That contest aimed to find the best idea for recasting an urban area that comprised Gwangbok Street and an area of cinemas named Piff Plaza, where the annual Korean cinema competition with its related shows and exhibitions takes place. The design contest was open to qualified architects from all over the world and it focused on the qualification of an urban space, encompassing streets, pavements, squares, urban furniture and equipment. Mr. Insung Kim, a Korean citizen and also a PhD candidate of the University of Sheffield at that time, and I decided to enter the competition as a team.

On that occasion it was seen that the application of IT resources - sensors, displays, servomechanisms and others – was considered a good way of revitalizing an urban area by way of supporting the design solutions provided, thus reinforcing them (more details are provided in page 200). However, it soon became clear that IT applications were not to remain confined to the subordinate role of supporting design; instead they became the principal factor in that project. Among others justifications for the elevation of the role of IT, it was alleged that it could adequately improve the qualities of the place without the need for the much more expensive physical modifications and refits. The conjugation of wireless technologies, hand-held devices and specially designed servomechanisms was considered to be less intrusive in the environment and consequently could constitute a more economical form of intervention.

Nevertheless, however much those justifications sounded persuasive in the context of that opportunity, in reality specific studies correlating the reduction of costs and the use of wireless technologies for urban design were lacking. Furthermore, neither did studies regarding IT applications as a means of improving or reinforcing the qualities of a place, such as those of *territoriality*, *privacy*, *identity* and *ambience*, exist.

Actually, up to the time of writing, few of the existing studies have focused on general questions about the application of ubiquitous computing in urban design. A few experiments have been made with installations in some urban settings, and most of them have had a strongly artistic character, such as, for example, in the case of those of Toyo Ito, using mixed media (Puglisi 1999), or more recently, those of Lozano-Hemmer, using interactive resources through the internet (Lozano-Hemmer, Rafael et Al 2000; Lozano-Hemmer, Rafael 2005). The other few studies have only focused on the indoor principles of Ubicomp, as in the case of the *EasyLiving project* by the Microsoft Research team (Brumit and Shapher 2000), but this did not establish any architectural model for understanding how to use IT in projects to do with places. The biggest contributions to the debate had addressed their attention to broad discussions, adopting diverse standpoints, which were not directly related to architecture or urban design, as is the case with those studies concerned with philosophy (Ilharco 2002; Chalmers 2006), cultural and social sciences (Gillespie 1992; Castells 2004; Sengers, Kaye *et al.* 2004), geography and politics (Graham and Marvin 1996; Graham 1998; 2001), and economics (Castells 1989; Castells 2000).

Few authors had undertaken studies dealing with the physical and geometrical implications of the application of IT to place, one of the few exceptions being McCullough (2004). All the same, even that author did not offer a complete theoretical approach oriented to architects and focusing on the activities that they really need to cope with during the design process.

In spite of the intention to design a relatively non-intrusive project for the Gwangbok International Competition in 2005, the end result was an outcome that was very far from what had originally

been intended: at least in comparison with the projects of the other contestants It also demanded more physical refurbishments to support the ubiquitous computing system that had been designed. It also required many others gadgets specially designed for it. This clear contradiction, together with the absence of a specific theoretical approach that has already been referred to, led me to pose the first question of my research:

- *Which theoretical approach could be developed in order to support the application of IT resources in the design of public urban spaces?*

That initial question was unfolded in terms of other important questions, such as:

- *How could such a theoretical approach correlate spatial elements, activities and the flux of information in public urban spaces?*

Consequently, it also induced an investigation on the following question:

- *How could such a theory explain the changes in those correlations when the urban space is affected by spatial conflicts?*

Other derived questions were as follows:

- *How could such a theoretical approach, regarding the use of IT in urban spaces, support architects during the design process?*

- *In what way would the resultant projects be better and more efficient than those without any theoretical support?*

Those questions raised the problem of understanding the qualities of places in terms of their physical characteristics and of regarding Ubicomp systems as a means to integrate, reinforce and improve those qualities. In this sense, the use of IT in urban areas should be justified by reasons beyond the mere possibility of cheaper solutions, since this does not reflect any essential criteria of efficiency. Rather, the first issue involved in the evaluation of the use of Ubicomp appeared to be, from that moment onwards, the benefits, advantages and limitations for people who use and live in places where IT is applied.

In other words, IT applications could be considered as a kind of dwelling '*support*', i.e. it could be considered as being integrated in a space in order to support life for the inhabitants and users. It was this consideration that first drove my attention towards the possibility of creating an architectural approach by linking the elements of a place and the very components of IT in an encompassing theoretical construction.

The organization of this thesis

This thesis is divided into eight chapters, ending with conclusions and suggestions for future research. The first chapter discusses the key ideas of information, technology, space and society. Although this suggests a broad discussion, it strictly reflects the aim of the chapter which is to observe, in depth what branches of the literature have offered insights about Information considered from an architectural perspective. The chapter will introduce a question concerning a

systematic exclusion of approaches that consider the real and physical attributes of places to relate to IT and its features. In part it can be observed that came about because architects have been reluctant to take a position in the discussion of Ubicomp. But, it will be argued that the discussion of IT and its application to real space has been delayed by what has been called the '*rationalistic tradition*' (Winograd and Flores 1988) which offers a mechanist idea of the model of communication. That model will be summarized and its main problems scrutinized. After this, the chapter will consider some alternatives to that tradition, and the idea of biological cognition developed by the Chilean neurophysiologist Humberto Maturana (1980) will be introduced. Central to this view is the idea that information is a pattern of complex phenomena, which Maturana regards as '*disturbances*' both caused and suffered by systems located in an environment. It will be seen that, on this point of view, the very space itself can be regarded as a participant in a process of communication which will permit us to understand the environment as a result of a species of interaction that belongs to the linguistic domain. In other words, information will be considered as the very element that '*in-forms*' the space, and a topological structure will be suggested, based on some definitions of the characteristics of place provided by some authors.

Chapter Two and Chapter Three are concerned with aspects of a place-theoretical framework developed in this research. They are a result of two years of development and the application of the theoretical framework to help architects in the design of the use of Ubicomp in urban spaces. Thus, its structure was amended after two applications for urban design projects that featured IT augmentation conducted by architect students as part of a module in the University of Sheffield's Master's course in Architecture in the years 2006 and 2007. The first part of the framework addresses an attempt to unify theories around the understanding of place. *Place* will be regarded as qualified space; and this qualifications takes place in the process of differentiation from outside space. Activities and spatial elements inside will refine the place, imbuing it with four main qualities, which are *territoriality, privacy, identity* and *ambience*. It will be shown how those qualities are related to physical properties. Considering place as a kind of equipment for dwelling (Heidegger 1975), the concept of urban place will be derived from architectural place and the possibility of viewing the breakdown of the spatial elements of the place as the origin of the conflicts with the activities that are lodged inside it will be suggested. Thus, the method of '*reading spaces*' by identifying conflicts will be introduced (Malard 1992) as a means to delimitate the use of IT in the solutions provided to address those conflicts.

Part II of the framework is outlined in Chapter 3. It will be focused on Information Technology in the context of place, and pay special regard to the spatial relations between components, functions, the activities and spaces that can be related to its use. The digital technologies components will be described as those that enable the place to be *sensed, modified* or *represented* (through models), thus comprising an entire Ubicomp system. The place itself, with its topological structure of information will be included as a means to facilitate reasoning about information and space. After this, components of digital technologies will be described by correlating their functions and uses - potential or real – in relation to some properties related to place that differentiate the inside from the outside (*interiority/exteriority definitions*), control the connection with the exterior (*visibility*) and maintain the definition of the interior (*appropriation*). After describing those correlations in tables, the components will be related to the four qualities of place. Finally, a strategy of using the tables will be suggested as a means of systematically helping architects in coming up with solutions to conflicts that deploy the use of digital technologies components in conjunction with space that emerge during the project, as well as new designs for IT gadgets and systems.

Following the framework described in Chapter 3, a methodology of research will be explained in Chapter 4, introducing a focus on case studies in order to improve the application and testing of the framework developed. Three separate instances will be studied: the project for the urban refurbishment of Gwangbok Street, South Korea (2005); the Fargate Street project, Sheffield, United Kingdom (2006); and the project for the digital augmentation of the concourse campus

space at the University of Sheffield, United Kingdom (2007). Two of these three instances employed the framework to support architects in the design of the use of IT in urban spaces. The method will establish that the resulting drawings and rationales for those projects will need to be examined separately in order to find evidence of the influence of the framework's concepts. To conduct such an examination, the key research questions will be unfolded in terms of *expected outcomes*, suggesting which results are to be expected in light of the proposed place-theoretical framework that aims to enable architects to better cope with the design of IT uses. Bloom's (1956) model of levels of understanding will be used to state the expected outcomes.

Three case studies will be presented in Chapters 5, 6 and 7. The structure of those chapters is the same, comprising the description of the place, the problems identified in terms of conflicts between spatial elements and activities, the solutions provided by the architects, and finally the evaluation of the project. That evaluation comprises the analysis of all items of evidence within the drawings and project rationales that indicate whether or not the outcomes expected were achieved.

Chapter 8 will observe more closely the results of the outcomes from the projects that have used the framework, and it will include the Gwangbok experiment, where a theory structured to support the design was absent. The outcomes will be analysed together as well as separately, thus permitting us to generate some inferences about the efficiency of the framework. When analysed alone, each case with its relative data will justify the amendments made to the framework, and will give a view in relation to its efficiency and weak points. By comparing all three projects, a general idea will be drawn, pointing to a best possible position to address the key questions of this inquiry.

The final section, Conclusions and Future Research, will respond one by one to the key questions, considering the discussions developed in Chapter 8. The conclusions will be summarized and some suggestions for future research will be made. Mainly, it will be seen that it was possible to develop some fundamental parameters together with the framework, permitting the architects to understand and discuss the concepts implied, using their own language. It will be suggested that the framework, being the result of a process of refinement that came about through application, should be regarded as incomplete and subject to continual research in order to take advantage of the constant advance of the technological fields. Its efficiency will be graded and the problems will be discussed.

Finally, the section '*Appendices*', in the Volume II, includes all the transcription and copies of documents quoted and cited in the main text, permitting cross references to be made with the relevant and related topics.

Chapter 1: Information, Technology, Space and Society.

Chapter 1: Information, Technology, Space and Society

In the introduction to this thesis it was mentioned that an international contest concerning ideas for an urban project was the starting point for the key questions that lay behind this thesis. In 2005, the competition addressed the revitalization of Gwangbok Street and Piff Plaza, in Busan city, South Korea (see on page 200) led me to wonder if a kind of framework could be developed to support the design of Information Technology for urban places. It was clear, at that time, that conceptual information and the technical specification of individual elements of IT were too unfamiliar to us to be used during the design process. Our framework at that time was not good enough to correlate space and information, and, therefore, it neither enabled us to conceptualize the initial intentions of the project clearly, nor justify the design solutions.

In terms of results, we tried to employ IT to compose a system integrated with physical interventions, aimed at reanimating Gwangbok Street. Among other solutions, the use of devices with radio-frequency identification, interactive light projectors, servomechanisms and other gadgets connected to web sites and to others movable gizmos was suggested. All those solutions were generically specified with extreme difficulty, as can be observed on page 205, in the project rationale. Since that contest addressed initial ideas only, as architects we were working in a team without a professional IT specialist to support the design, and even if such a professional were available at that time, there was no common language that would allow us to conjugate both the technological and spatial elements and put together an initial concept for the project. Despite the fact that most IT solutions were related to the kind of invisibility and immateriality that is provided by wireless technologies, physical interventions were still needed and, above all, its integration with the physical space was thought of as being capable of reinvigorating local *identity* and other qualities, like *territoriality, privacy and ambience* (see section 2.3 on page 41).

At that time, the initial insight was that the geometrical and physical properties of place could be studied in the light of the information phenomenon involved in the mutual interferences between activities that take place in the place itself and its physical elements. Then, by observing how the Information Technology could better connect local activities and their spatial supports, my intuitions were, firstly, that it would be possible to study a kind of topology of information associated with the topology of the place and, secondly, that that topology could be translated geometrically into architectural solutions using digital technologies components associated with physical interventions. For this reason, initial reviews of the literature have contemplated on the pursuit of relations between information and space, expanded across a broader perspective, which includes the mutual interferences between technological development and the social appropriation of space. Since this approach guided the literature review, some authors and titles were chosen

whilst others were deemed to be beyond the scope of the present discussion. This presents us with a convenient juncture to justify these decisions.

The approximations that resulted from the aforementioned perspectives and which were examined in the literature review were characterized as stemming from two main streams concerned with the mutual influences at work between technology and society. Basically, the main point was whether technological development would lead to social changes that would be exemplified in the way people use the city's space or - vice versa – whether the social milieu would determine the evolution of technology. Probably the most popular point of view studied in the review was from some authors who have pointed out that IT has caused a revolution in society, prophesying impacts that that technology will produce in the social milieu. Through the study of the literature it was observed that in recent years IT has been considered by authors of the aforementioned tendency an independent agent of change, separated from the social world and to be able to impact on it in wave of change that is both predictable and revolutionary. This deterministic point of view predicted that IT would shrink physical distances (Virilio 1993), providing for a generalized interactivity based on its pervasiveness (Stefik 1996). Using spatial and territorial metaphors (Gillespie 1992), those predictions referred to the networked connections as '*electronic space*' which would parallel and substitute the inhabited material spaces of human territoriality. Through the use of that '*electronic space*' – *cyberspace* - actual distances would fade as a constraint on social, economic and cultural life, occasioning the effective dissolution of the city (Virilio 1993). With virtual reality (VR) technologies, *cyberspace* would even provide all the richness and subtlety of the immersive communications available only through place-based interactions in urban areas, pointing out that real space and place would become unnecessary. However, inside this perspective lies the idea of a '*crisis in the notion of physical dimension[s]*' of space, place, region and city (Mitchell 1995). In other words, '*net negates geometry*', as Mitchell declared (quoted in McCullough 2004: 98).

The review has shown that some years after the futuristic predictions made by this deterministic tendency, IT is now regarded as being bound up with the production of material spaces. Many relational points of view analyse the articulation between place-based and electronic networked relationships and the linkages between telecommunications and the city. It reinforces the idea that materially constructed urban spaces and IT networks stand in a state of recursive interaction, shaping each other. '*Contextual computing begins from the physical geometry*', as pointed out by McCullough (2004: 98).

Thus, the implications of IT for the physical world, far from simply collapsing spatial barriers or unifying everything within a single cyberspace, will enhance the commitment of different social and cultural interest groups to particular material places within diverse networks. From this point of view, place becomes an embedded and heterogeneous range of spatial process that always needs to consider a continual recombination of people's activities, their specific places and the different ways of interaction they use. Once the existence of this point of view was established in the bibliographic review, many of the recent authors were classified according to one or other of two categories regarding their view of IT and the social appropriation of space. For that reason, even some recent contributions were considered, in this review, to emphasize the deterministic bias. As such, they only tangentially touched on the scope of this thesis, and, therefore, are only briefly mentioned.

As can be inferred from this introductory reasoning, the initial key research question led to a revision of the relations between information, technology, space and society, and a point of view were observed to guide the revision. Therefore, as a task derived from that initial question, this chapter will review the mainstream related literature in order to support understanding of those correlations.

1.1. Structure of this literature review

To better identify how information can be regarded as an influential factor over physical space, the definition of the term will be initially discussed through a review of the signification of the word, including its etymological origin and the changes and adaptations of its meanings throughout the course of modern history.

It will be seen that ever since the period immediately following the Second World War, information became an idea around which many sciences and disciplines gathered, contributing a diversity of meanings to the idea that were very far from the general or universally understood meaning of the term. Therefore, nowadays it can be regarded as a concept, as a process or an object, depending on the social processes implied in each point of view. As a concept, information is considered to convey meanings; as a process, information is regarded to promote changes in the social panorama through emancipation or new arrangements of power; and as object, a wide variety of characteristics have been attributed to information, from the meaningless auto-referent objectivity identified in earlier theories of communication, to a commodity with a monetary in those perspectives that have an economics bias. Thereafter, information has come to mean nowadays an abstract phenomenon, both decontextualized and fluid which can hardly ever be related to physical space or place, except in those few abstract references to it as a flux across social space.

The diversity of significations results from a crisis in scientific approaches to the phenomenon. Ever since the Second World War, an increasing tension grown up inside the new disciplines related to information, such as cybernetics, the general theory of systems and computing. Other Diverse sciences, such as biology, psychology, physics and others, obtained influential approximations to those disciplines, and thus bequeathed their own peculiar approaches to the idea of information. These approaches will be referred to here as 'mechanistic' perspectives, which are characterized by their use of an array of concepts based on mechanical analogies to understand communication. For instance, through the 'mechanistic' perspective, the phenomenon of transmitting information was explained by depicting a generic emitter delivering information to a receptor, through a medium. That model is structural in some approaches, and is usually used to explain cognition as knowledge acquired through instructive interactions in a communicational process. At the first sight, this has the potential to reveal how the medium could be studied, for instance, as a physical element with spatial properties, thereby implying a number of considerations that could prove useful to this research. However, in the case of this research it will be argued that this 'mechanistic' model is based upon a mistaken view of the phenomenon.

Thereafter, attention will move on to the tangible forms of information focusing on the deployed technology and its relationship with the human activities in places. With this focus in mind, theories of technology will be revised (Feenberg 1991; Arnold 2003) and classified in terms of their potential to contribute to the present inquiry. Classifications of point of views, such as '*substantive*', '*determinist*', '*social construction*', '*actors-network*' approaches, and other mixed contributions, are studied as ways in which the whole panorama of technology has been regarded. After that, an analysis will be made of the three dominating perspectives identified by Graham (1998), which are '*substitution and transcendence*' of the physical world by IT, '*co-evolutionary*' process of development of real and virtual spaces, and finally a '*recombination*' of both real and virtual places. In the last perspective, how IT has been acting, connecting and recombining real and virtual spaces dynamically in new sets of spaces and times according to the impulses of social life will be examined and commented on.

Regarding the importance of the relation between society and IT, the theory of Henry Lefebvre will be studied (Lefebvre 1991), which deals with the process of the production of space. It will be shown that, in this theory, the production of space comprises an interwoven process of interaction between three types of space: *the physical*, *the mental* and the *social space*. Out of that interaction, corresponding spaces of 'action' emerge: *the perceived space of the spatial practice*, *the conceived space of the representations of space*, and the *lived space expressed as representational space*. Following Conrad's suggestion (2006), the concepts of '*practiced*', '*conceived*' and '*lived*' spaces will be then linked to concrete examples of IT, emphasizing their spatial implications.

In an attempt to find alternative revisions of the concept of information and space, the ensuing discussion of the aforementioned mechanistic perspective will point out that these actually emerged from sciences that had suffered from the scission of their philosophical basis (Broadbent 1973; Perez-Gomez 1983; Winograd and Flores 1988; Capra 1996), resulting in a methodological crisis that arose from the analytical separation of subjectivity and objectivity, cause and effect, and time and space in such studies. That crisis has led to two the growth of two main branches, roughly characterized here as 'empiricism' and 'rationalism'. What will be emphasized here is the need to break through the narrow 'bottleneck' of that exists in mechanistic approaches in order to retrieve a human dimension from information studies.

In continuation, the chapter will describe a second generation of cybernetics that started began in the early 60s and received diverse contributions from recent philosophical and scientific developments. Instead of taking a mechanistic approach, they regarded information as part of a holistic paradigm. The contributions of Heidegger (Heidegger 1962; Heidegger 1969; Heidegger 1975) and Maturana (Maturana 1978; Maturana 1980; Maturana 2006) will then be examined, showing how they reconcile information, technology and society, and offer clues to the composition of a theoretical framework about information and space.

Finally, taking a critical stance on the mechaniscist paradigm of information, some examples of alternatives approaches will be seen. The investigations led by Maturana (1978) in biology will be analysed in order to conclude that, in the interactions living systems, both among themselves and with their environment, no information is delivered or received. The mechanical view of communication will be regarding as having failed to explain how living systems adapt themselves to cope with detectable disturbances around them, and it will be concluded that they are able to survive when their closed, determined, but plastic structures allow them to make adaptations towards a structural coupling with other systems, be they other organisms or their own environment. Therefore, those adaptations are a way of gathering information about how to live, which means that information is regarded as disturbances that are reflected in structural changes to the systems themselves. Taking this biological point of view, "*cognition*" will be regarded as the very living process itself (Maturana 1980).

According to Maturana's point of view, the structural adaptations made by living systems both in terms of each other and with the environment are behaviours that draw up a consensual and cooperative domain which may be regarded as a 'linguistic' one. Human languages, on this view, are considered one particular achievement, but the way living systems, whether cells or humans in a society, organize themselves physically in the environment and can be regarded as a implied linguistic and informational phenomenon. This theoretical approach will be useful when it comes to concluding that a place is the result of a process of spatial organization in which the spatial elements play the role of an informational phenomenon.

1.2. A concept of information

As a descriptive adjective, the word '*information*' has become a confusing term, either used ambiguously to cover both a wide range subjects and rather specific ones. This confusion is present in the collection of multiple significations that have been generated in its application to a bewildering range of different practices, which are implied and suggested, for example, in terms such as '*information age*', '*information society*', '*information economy*', '*information superhighway*', '*information revolution'* as well as many others. On the other hand, it is used too precisely, and its meaning has become attached too narrowly to specific technological functions, such as '*data'*, '*bit'*, *'emitter', 'receptor'* and the like. A revision of the meanings will show that, in both those cases, '*information*' has been regarded solely through the lens of a mechanist point of view in the various sciences, and a new paradigm is required so as to reveal more accurately the underlying issues and move towards an analysis that aims to focus on spatial issues.

The original meaning of the word, which derives from Latin, connects it to space by suggesting the act of shaping a content: '*informare'* means '*to put in form*' (Wyld 1959). '*Informing*' therefore carries the sense of '*imparting learning or instruction*' or more generally conveys the sense '*to tell one of something*'. In English, a current definition of information is '*something told; knowledge of a fact, facts learnt*' (Wyld 1959). The word was coined in the 14th century (MW), later gaining two connected meanings: one of which is the communication of something, an event, a fact or a story; and the other, referring to gathering data, obtaining '*knowledge*' from investigation, study or instruction. Within the context of the development of science, '*knowledge*' has been consistently distinguished from '*information*'. The differentiation, in terms of multiplicity, is that '*information*' is piecemeal, fragmented, and particular, whereas '*knowledge*' is structured, coherent and universal. In terms of temporality, '*information*' is timely, transitory, and ephemeral, whereas '*knowledge*' is enduring and temporally expansive. Considered metaphorically in terms of spatiality, *'information'* is generally considered like particles in movement, flowing across *spaces* (e.g.: Castells 2000), whereas '*knowledge*' is regarded a place, as a stock, specifically located, yet spatially expansive. In summary, the current distinction between '*knowledge*' and '*information*' is that '*information'* is a process, while '*knowledge*' is a state (Machlup and Mansfield 1983: 642).

Despite the fact that the study of '*information*' is comfortable and easy when the most current meanings of that word are considered, the question '*what is information*' is actually not to be taken as a request for dictionary definitions. According to Floridi (2002), since the end of the 1990s, the investigation of the meaning of '*information*' should provide the means to demarcate a wide area of research which has been recently defined by him as the '*philosophy of information*'. Discussing the characteristics of such new field in philosophy, he points out that:

> *"Because information is a multifaceted and polyvalent concept, the question 'what is information?' is misleadingly simple, exactly like 'what is being?'. As an instance of the Socratic question 'ti esti...?(What is it?)', it poses a fundamental and complex problem, intrinsically fascinating and no less challenging than "what is truth?', 'what is virtue?', 'what is knowledge?' or 'what is meaning?'. It is not a request for dictionary explorations but an ideal point of intersection of philosophical investigations, whose answers can diverge both because of the conclusions reached and because of the approaches adopted" (Floridi 2004).*

Thus '*Philosophy of Information*' should be concerned with the critical investigation of the conceptual nature and basic principles of information. Its study should include the dynamics of information, its utilisation and sciences, and the elaboration and application of information-theoretic and computational methodologies to philosophical problems. It means that the task of the

new philosophy is to develop an integrated family of theories that analyse, evaluate and explain the various principles and concepts of information, their dynamics and utilisation, with special attention to systemic issues arising from different contexts of application and the interconnections with other key concepts in philosophy, such as knowledge, truth, meaning and reality.

In order to demarcate the origin of the new field of *Philosophy of Information,* Floridi (2002) mentions that, according to Aristotle in his book '*Metaphysics'*, information '*can be said in many ways'*, like '*being*'. This correlation is probably not accidental, meaning that information, like its derived concepts, such as *computation, data, communication etc.*, plays a key role in the ways in which is possible *to understand, to model and to transform reality.* Thus, analysing the dynamics of the relationship between '*information*' and '*reality*' Floridi mentions that this can normally be regarded from three perspectives:

- *Information as reality*, which means information as the presence of physical elements which are neither true nor false. This is also known as *ecological information*;
- *Information about reality*, which is the semantic information, such as an ingredient of the constitution of knowledge;
- And *information for reality*, meaning the instruction, i.e. genetic information, algorithms and recipes.

It will be seen that the concept of *ecological information* corresponds to a kind of approximation to the use of the term '*information*' in this research. The concrete way through which the very space plays a part in the process of shaping the activities being shaped by them will be considered here as '*information*'. That mutual shaping will be regarded as disturbances through which space and activities influence each other by means of what will be called *conflicts*. Solutions to *conflicts between space and activities* will be thus regarded as the phenomena that express the communicational organization of the environment, reflecting its linguistic structure.

1.3. Dematerialization

After the Second World War, information became the key term that united a diverse number of technical and scientific disciplines: biology, cognitive science, information science, computer science, psychology, physics, economics and so on (Feenberg 1991). Under the consideration of information, new disciplines emerged, such as the theory of communication (Shannon and Weaver 1949), theories of systems (Bertalanffy 1968) and cybernetics (Weiner 1961). It is believed that the development of sciences around information was first formulated within the discipline of symbolic logic in 1930s (Feenberg 1991). Logic, here, was reoriented away from concerns with the material representation of reality towards a focus on purely formal criteria and rules, thus permitting the conceptualization of a wide range of problems in many different areas of intellectual endeavour, from maths to social sciences and politics (Pylyshyn 1983).

In the late 1930s, Claude Shannon, credited as the founder of *Information Theory*, saw that the principles of logic (in terms of true and false propositions) can be used to describe the two states (on and off) of electromechanical relay switches. He thus suggested that electrical circuits could embody the fundamental operations of maths. In the 1940s, working on the engineering problems of signal transmission, Shannon and Weaver (Shannon and Weaver 1949) further developed the key notion of *Information Theory*, introducing the key understanding that information can be thought of as divorced from the specific content of a message and that it can be simply defined as a

single decision between two equally plausible alternatives. For this reason, the basic unit of information to Shannon is designated with the term 'bit' (Shannon and Weaver 1949).

Inside the thinking of Shannon and Weaver lies the mechanist idea of information. That idea is a strategic way to analogically think of information as something that is carried from an emitter to a receptor via a medium. This strategic way to think enabled the separation of analytical elements in this system, defining binaries and permitting the study of probabilities related to the elements. Therefore, this model is not interested in the usefulness, relevance, meaning, interpretation or reference of data, but in the level of detail and frequency in the *uninterpreted* data (signals or messages). This analogy has led to the development of a successful mathematical theory because at its core it is concerned with *whether* and *how much* data, rather than with what information is conveyed.

Thus, Shannon's communicational system is in symmetry with the idea of separation between cause and effect (see on page 20). It will be seen that this strategy has caused oversimplifications in the understanding of information phenomenon. In fact, ever since Shannon's communication theory was developed, as a consequence of the influence of that oversimplification, information started being conceived of in many other fields as discrete bundles, physically decontextualized and fluidly moveable. One example is in the *social systems*, through the *systems theory*, where that concept was used to explain society's communication circuits and its means of control.

The mechanist idea of information, as it is being called here, flourished in many other fields, but not in all of them. In the course of the 1950s, information became identified with the secrets of life, associated with studies on brain functions and the DNA genetic code. By the 1970s, it had achieved a more exalted status, having become a commodity in business (Roszak 1986), in the all-embracing debate about its value, its distribution, and the implications of its being considered privately or collectively owned (Morris-Suzuki 1997).

As an abstract mathematical way of thinking, Shannon's model was very influential in many fields. One of the most common oversimplifications caused by the mechanist idea of information was its dissociation from its context. Taking a sociological point of view, this reflected in the dissociation between information, space and human activities reflected that means the diversity that was understood to represent society in the broadest sense. It is now time to observe how that sociological point of view can be correlated to information.

1.4. Sociological and scientific aspects

Ilharco (2002) mentions that as information has been studied from many theoretical perspectives in order to underlay different assumptions, a universally accepted definition is not possible. However, an attempt to classify the diversity of concepts is seen in his adaptation of Burrell and Morgan's (1979) classification of sciences' in order to analyse the relationship between information, social dynamism and nature of the sciences.

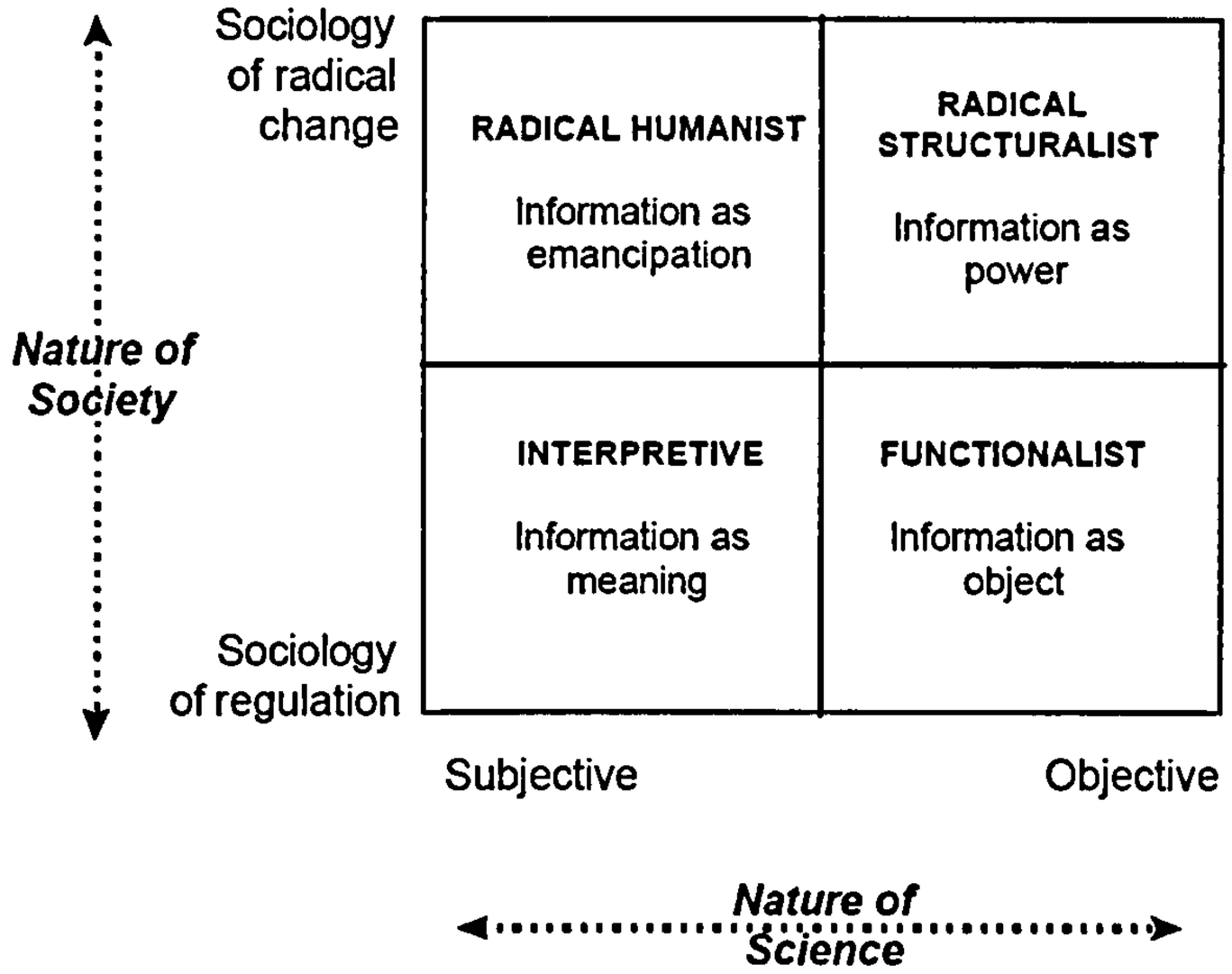

Figure 1: Four Paradigms on Information (Ilharco 2002)

According to Ilharco (2002), information emerges as a diversity of notions, concepts or objects depending on whether it is studied and developed within any of the theoretical paradigms outlined in Figure 1.

In consideration of the *subjective* nature of science, that implies a *rationalistic point of view*, and that, therefore, the phenomenon of information is entangled with phenomena related to meaning and social emancipation. It is an *interpretative* and *subject-dependent* phenomenon, relying on the individual consciousness of the subject who experiences the world always from his own context. As examples of authors who adopted the *Interpretive paradigm*, Ilharco (2002) suggests Introna, Boland, Daft and Weick.

The *Radical Humanist paradigm* assumes information to be emancipation, sharing the notion of *information as meaning*, but also considering a dynamic social process. To the *Radical Humanist* point of view, since society is dynamic, contradictory and *conflictual*, information plays a role as a factor concerned with *emancipation*, in the process of social communicative action. Ilharco (2002) cites Feenberg, Hirschheim and Klein, Habbermas, Husserl, Iacono and Markus and Bjorn-Andersen as some authors who take this approach,.

With regard to the *objective nature of science*, this means an association with an empiricist conception, and here information is regarded as an *object*, whose transformations require power. Therefore, the *radical structuralist* paradigm focuses on the material relationships: the ones who dominate, the ones who are dominated and the synergy among them. Foucault, Callon, Zuboff and Law are some representative authors of this view.

For the *functionalist paradigm*, information is an *object*. An approach that exemplifies the functionalist view is Shannon and Weaver's aforementioned communication theory (Shannon and Weaver 1949). Subsequent theories have preserved their notions, as can be detected in such quotes as:

> '*Information can be defined in terms of its surprise value. It tells the recipient something he did not know*' (Davis G.B. and Olsen 1985:30, quoted in Ilharco, 2002);

> Information is a *'tangible or intangible entity that reduces uncertainty about a state or an event'* (Lucas 1990: 513, ibid.);
>
> and '*Information is a difference that makes difference*' (Bateson 1979, ibid.).

Despite being so widespread, some concepts derived from the *functionalist* branch, are problematic, such as, for example, data and information and the differences between them. According to the mainstream literature, meaning and context are what distinguish these latter two. For example, data is '*any representation such [as] characters or analog quantities to which meaning is, or might be, assigned*' according to Ansi's manual (1990, ibid.); and information to Hicks is '*data that has been processed so that it is meaningful to a decision maker to use in particular decision*' (1993, p. 675; ibid.). Ilharco (2002) argues that data is already meaningful, and such definitions obscure the a priori nature of information as such. It will be seen, that this problem derives from the aforementioned mechanist way of thinking about '*information*' that is evident throughout the sciences.

1.5. Technology and social life

Encompassing the complexity through which technology and social life frame each other, a different approach to the meaning of '*information*' is taken by Arnold (2003) in his study of the paradox inherent in the achievements of the information technologies. Arnold discusses how IT and Technology, in a broad sense, are reflected differently across social organizations within various contradictions and paradoxes. He summarises the philosophical views in five classifications which are: '*substantive*', '*determinist*', '*social construction*', '*network*' approaches, and the others are '*mixed*' contributions.

'*Substantive*' approaches have the same meaning as that used by Feenberg (1991), which relies upon a modernist logic that links a technological essence to a known or knowable social impact or social condition. Here, the essence of technology and science lies in the ability to efficiently and effectively express power over nature and the human condition, and thus potentially assert control. The power of technology lies in its ability to affect the shape and expression of human will, and it is based upon the human exploitation of the laws of the universe, as revealed by the modernist sciences of physics, chemistry, biology, mathematics, and their related disciplines. According to Arnold (2003: 236), some of the examples of '*substantive*' contributions that ought to be considered are those of Heidegger (1969), for whom humans apprehend and constitute the world through a technological framework. However, this does not mean that according to him technology answer this or that question specifically; and neither does it satisfy this or that demand, nor extend this or that capacity. Rather, technology works at a more fundamental level, framing the world in such a way that the question is changed along with the answer, the need is changed along with its gratification, and direction is changed along with the mechanism. Heidegger argues that humanity cannot reject or eradicate technology because it is, after all, *the* way of being *human* in the world. By giving primacy to the place of meditative thinking rather than calculative thinking, humanity should embrace technology by releasing it:

> *"We let technical devices enter our daily life, and at the same time leave them outside, that is, let them alone, as things which are nothing absolute but remain dependent upon something higher. I would call this comportment towards technology which expresses 'yes'*

> *and at the same time 'no' by an old word, releasement towards things."* (Heidegger 1969: 54, quoted in Arnold (2003))

A '*determinist*' perspective on technology is described by Arnold (2003: 237), suggesting that specific technologies or clusters of technologies determine social conditions and drive specific social changes through historical eras. Different from the other perspectives, this comprehends approaches that link particular technologies to particular social outcomes. On face value, this perspective excludes contradictions in terms of those outcomes, since technology is regarded as independent from social context. Arnold makes clear, however, that it happens because this perspective derives from the modernist usage in the field of knowledge studies (epistemology), which makes three binary divisions: the separation of time and space (privileging time), subject and object (privileging subject), and cause and effect (privileging cause). This strategy enables technology to be separated analytically from society in symmetry with the separation of cause and effect. Analysing how information is found to be related to technology in this point of view, Arnold comments:

> *"Having made this crucial move to separate society from technology, and to purify the essence of each, (a move so much engrained in our traditions that it is scarcely visible), it becomes possible to stratify by aligning technology with causality and society with effect, producing McLuhan's Global Village, Bell's Information Society, Marcuse's One Dimensional Man, Toffler's Third Wave, Mitchell's City of Bits, Poster's Second Media Age, Gates' Frictionless Economy, and so on."* (Arnold 2003: 238)

The approach termed the *Social Construction of Technology* is described by Arnold (2003) as one that sees society and its imperatives as being prior to the technologies that emerge from them. Like the determinist approach, social construction operates within the modernist framework, and uses the same determinist logic, reliant upon linking linear chains, from social cause to technical landscape. It also cleaves and separates the technical from the social, in ways that are arbitrary and analytically questionable, but are required if the social is to be privileged. After having made this arbitrary distinction, social and technical are connected, with the latter being depicted as a consequence of the former.

Yet other different approaches use networked analogies. For these, technology is both a cause and an effect, and the social is both a cause and an effect as well. This means that each is both emergent and structuring. This point of view is achieved by collapsing the modernist distinction between the two, and referring instead to the performance of an actor. '*Performance*' may be thus be taken to mean the cluster of actions that constitute the usage, and emerge in the course of the use, when the whole ramified and a very extensive assemblage of heterogeneous beings call upon one another to cooperate, and do so. The ontology of any given actor, its origin and meaning, is a matter of its relationship in any given network, and the ontology of the network as a whole is also a matter of its internal and external relations. The relational linkage of the system and the way those links generate hybrid forms linking humans, objects, situations, is the fundamental unit of analysis. Concentrating on uncategorized forms of interconnection and relation, on undifferentiated imbroglios of politics, physics, machinery, bureaucracy etc., all situated within the same frame of analysis, the networked approaches do not foreclose the coexistence of contrary implications or paradoxical observations. Therefore, multiple, though overlapping, ontologies coexist, and even contrary implications are possible.

Other contributions that mix information and technology are studied by Arnold (2003), such as that by Ihde (1990), who refers to technological mediation in phenomenological terms, drawing particular attention to the necessary co-occurrence of amplification and reduction. That means, an increased capacity to engage with the world in a particular way is accompanied by a reduced capacity to engage with it in other ways - for example, the amplified view provided through a

microscope closes off the view of the room. Borgmann (1987) is mentioned as exemplifying an approach in which technological devices are seen as a mean to attenuate human engagement with the world, assuming more and more functionality until the point is reached at which social engagement becomes unnecessary.

Finalizing his summarization, Arnold (2003) argues that Heidegger's model of a '*lifeworld enframed by technology*', together with a networked logic that looks to an *ontology of hybrids* offers a better way forward for the investigation of technology. Arnold does not mention any special feature in his classification relating to IT and space, but it is possible to glimpse that the polarity between technology and society highlighted by him contains some ideas about how space is considered in each approach. For instance, by mentioning Heidegger's thought, he is implicitly assuming all the spatial implications of the Heideggerian concept of being-in-the-world. expressed as an action, as reflected by the word composed by the hyphenization, as an ontological unity acting in its place, the world. 'Networked actors' approaches (Latour and Woolgar 1979; Latour 1987), however, go even further, emphasizing place as action and revealing action as decisive to give meaning to linked actors, which means that all the categories rely on the situation whose links establish their connection. Space and place are, on this view, categories of concepts that are too narrow, whether thought of in terms of stable geometrical properties, referencing an immutable position in the world. This provides, at first sight, an idea of immateriality conformed by actions in space, that is, it will be seen, wrong. Such apparent immateriality, as a result of this analytical treatment, is problematic in terms of the objectives of this inquiry, and closer examples of a spatial analysis of IT could be useful when it comes to clarifying what the concept of space and place come to mean inside 'networked actors' approaches, and this will be discussed in the next section

1.6. Reality, virtuality and its combinations

One author who emphasizes networked actors theory, in order to better understand the meaning of IT technology, is Graham (1998). In one of his articles, the spatial implications of IT are described in terms of three dominating perspectives that are easily identifiable in specialized writings and discourses that were published throughout the 1990s: the '*substitution and transcendence*' of the physical by the virtual, the '*co-evolutionary*' process of both the physical and the real and a '*recombination*' of reality and virtuality by a network of actions.

According to him, the first perspective anticipates that technological evolution will cause a '*substitution and transcendence*' of the physical world, and this will happen through the disseminated use of electronic '*virtual spaces*', which will replace the space-based dynamics of human life. The second perspective sees both '*virtual*' and physical spaces as being produced in a '*co-evolutionary*' process as a result of the continuous restructuring of the capitalist political-economic system. And the third perspective mentions that there is a '*recombination*' of physical and '*virtual*' spaces, which IT acts connecting and recombining them dynamically in new sets of spaces and times according to social life. A brief analysis of those perspectives should reveal more accurately how information and space are related. From the perspective of '*substitution and transcendence*', technology is an independent agent of change, separated from the social world and impacting it, through some predictable, universal, and revolutionary wave of change. IT here is assumed directly to cause such social and spatial change in a simple and linear way. Since information will be available anytime and everywhere, and the entire world will be connected through networks, physical distance, as a socio-economic and cultural constraint, will disappear. Consequently, a geographical dispersal of metropolitan regions will happen, or even the effective

dissolution of the city. As the life and fluxes of the urban centres are gradually substituted by some universalized and interactive technique of communication, large metropolitan nuclei will gradually become a technological anachronism. In addition, the convergence of virtual reality technologies (VR) associated with powerful networks will transform all the relations that were once made through place-base interactions with '*virtual*' ones, decreasing the importance of real places. Thus, immersive technologies will create electronic spaceless cities in which VR will allow the construction of life-like 3D environments and '*Virtual spaces*' will finally substitute physical places. In conclusion, human societies, cultures and economies will migrate into the electronic environment, where it will be possible to construct identities with flexibility, accessing all services from any location, at anytime, sharing the experience of endless fantasy worlds. The very concepts of material space, place, time and body are irrelevant from this point of view.

On the other hand, to the '*co-evolutionary*' perspective, place-based interactions compose complex articulations between physical space and social life. Within the same broad societal tendency and social processes, the production of electronic networks and '*spaces*' co-evolve with the production of material spaces and places. From this perspective, three main trends of thinking have emerged. In the first tendency, physical space is considered important to contextualize the design applications of new technologies. In the second, on the city scale, IT articulates electronic representations of space and mobility to feed back positively into the dynamic development of a particular urban scene. Electronic representations of cities, for example, help to ground and integrate the web activities within a particular metropolitan area, adding coherence and legibility to an otherwise chaotic interplay between the internet and urban space. This also explains the flux of information through networked interactions, which actually represents and articulates real places and spaces, supporting and generating physical mobility, tourism, transport and trips for the highly mobile, elite groups that currently use it in the process. Thirdly, in a perpetual process of physical recasting, real places become increasingly shaped and constructed through their incorporation into powerful networks of flows and exchange. In conclusion, for the '*co-evolutionary*' point of view, material space and its electronic representation recursively support and shape each other.

In perspective just described, the social construction of technology is seen as a relational process which is to a certain extent stable. However, the third perspective will go even further. From the perspective of '*recombination*', there is a continual and dynamic recombination of the world taking place with the technological linkage of its elements. Relative to that momentary connection, people, things and their representations receive distinct meanings in the social scene. This recombination is contingent and temporal, according to each particular context. Consequently, physical space and places are not regarded as static, unvarying and external containers, but as transient and layered sets of meanings given by the endless process of the rearrangement of things. Neither is time considered as a constant, but its significance is given within terms of the social restraints. As a result, this ever changing representation of space, place and time enables the creation, inside social life, of different spaces and times, several forms of human interaction, control and organization. Thus, place becomes an embedded and heterogeneous range of time-space processes; neighbourhoods, cities and regions cannot be studied independently of the particular spatio-temporalities given by each socio-technological construction. Respectively, a huge variety of electronic representations of those different spaces and times creates the '*Cyberspaces*', which are various, not only one. '*Cyberspaces*' are, in this way, a fragmented, divided and contested multiplicity of heterogeneous infrastructures and human actors, acting as socio-technical networks, representing geographies of enablement and constraint, linking the local and non-local in intimate, relational and reciprocal connections.

After analysing those perspectives, Graham (1998) concludes with two main points: first, it is necessary to be wary of the dangers of adopting, even implicitly, deterministic and technological models and metaphors of technological change. Too often the complex relations between IT and space, place and society are obfuscated by those metaphors, like the use of terms such as '*virtual*

space', '*cyberspace*' and others. These are too simplistic to explain how new technologies actually relate to spaces and places bound up with human territorial life. Thus, a critical consideration in the reflections on the electronic representation of social spaces is preferable. Secondly, it is also necessary to be wary of the dangers of adopting simplistic concepts of place and space, since they cannot explain the complexity of contemporary life. By 'simplistic', Graham understands all the concepts which ignore the importance of social life. Those concepts need to be defined in relational terms too, as articulated moments in networks of social relations rather than as areas with boundaries around them. Only by maintaining linked, relational conceptions of both new information and communications technologies and space and place will an approach be permitted that has a full understanding of the inter-relationships between them.

These latter concepts, suggested by Graham (1998) are so complex that an immediate interpretation in the design process seems impossible, since they deal with a dynamism which is alien to the idea of stability and permanence normally present in architects' thoughts as a result of thinking about the duration of buildings and other interventions. By means of Graham's concepts of '*recombination*', only the set of facts that surround a problem-situation in a design project can act as a temporary medium through which space and place can be conceptualized. This means that each situation will require a different and circumstantial framework and analytical apparatus. IT, in this context, is understood as a support to the social apparatus in order to link the set of networked actors (things, people, and ideas). The social circumstances and the space will define each other at every point of those interconnections, and this is what is going to be discussed next section.

1.7. Information and the production of space

Henri Lefebvre (1991) addressed his concerns to the production of space with respect to social processes. His approach can be useful in clarifying some terminologies relating to space and social life, and, despite not being concerned specifically with computing, it can also provide some keys to the understanding of this study. Analysing different concepts of space in the sciences, Lefebvre also criticized the spatial metaphors used in some sciences, specifically maths and philosophy. In 1974, in his now popular book '*The Production of Space*', he mentioned that there is a distinction between '*discourses of space*' and knowledge of space. '*Discourses of space*' are essentially a consequence of the migration of concepts that have an implicitly a socio-physical nature to the interior of the language and the mental world. This means that the sciences have reduced the idea of the social space, its history and practice, by using abstract operations to compose a discourse which is not too far from those produced by purely descriptive methods. Similarly to the perspective of '*substitution and transcendence*' in Graham's article, a great process of '*metaphorization*' of the space happened through the western thoughts, according to Lefebvre. As a result of this, phenomena such as human wishes and dreams, the complex *"universe"* of spatial symbols which rules individual life and others that come from the relation between human body and space were studied from simplistic standpoints, leading to an irreconcilable separation and the establishment of polarities such as those between body and mind, the physical and the mental, objectivity and subjectivity.

Lefebvre argued that the basic understanding of the world originates from the sensory spatial relationship between the body and the world, and the meanings that we attribute to space are inextricably bound up with those experiences. Seeking a reconciliation of terms, instead of describing the body as Cartesian dyad (*res cogitans* and *res extensa*), Lefebvre described it in form of a triad, regarding three dialectical and distinct instances (Lefebvre 1991: 40) of social space: the

'*perceived*' (sensory experience of apprehension and cognition), the '*conceived*' (idealized experience based on professional or scientific knowledge), and the '*lived*' (concrete, subjective experience). Through these instances, the body is regarded as simultaneous subject and object, and is liberated from that duality through the dialectical process of the production of space. This leads to the distinction between physical, social and mental spaces. Lefebvre stated that social space will be revealed in its particularity to the extent that it ceases to be indistinguishable from mental space (as defined by philosophers and mathematicians) on the one hand, and from the physical space (as defined by empiricists) on the other. Thus, the unique properties of Lefebvre's social space allow it to become the site in which the physical and the mental, the real and the ideal, the subjective and the objective, the concrete and the abstract are concepts recursively and dialectically related in the production of the space. In spatial terms, the dialectical relationship composes three spatial 'codes': those of '*spatial practice*', '*representations of space*', and '*representational space*'. The spatial code helps to uncover the illusions of space that result from metaphors and unifies the spaces of social life by revealing common characteristics between divergent places.

'*Practiced*' space is a reference to codes of '*spatial practices*', which keep and reproduce the material and functional conditions of the members of the society in their quotidian routines. *'Spatial practices'* are closely associated with everyday experience and daily routines and define the actions appropriate to a specific locale, for example, the relationship of person to place through land use and exclusionary zoning or through social networks that demarcate space.

Within '*conceived*' ideas of space, codes of '*representations of space*' are used in the intellectualization process, which codify the spatial experience in languages of planning schemes and design discourses. '*Representations of space*' are, thus, consistent and coherent symbols of idealized types of space. They are the conceptualized spaces of professionals such as architects, engineers, and planners. It is literally a symbolic representation of space informed by the mode of production and the ideals of such specializations. The result is the production of distinct, separate, and often homogenized spaces, as it can be seen in the modern styles of architecture.

Through the '*lived*' experience of space – inside the private and personal realm - the sensual world of everyday life is recreated in a '*representational space*' that corresponds to '*the space which the imagination seeks to change and appropriate*' (Lefebvre 1991: 39), including those places which escape from interest of the market, and are produced and constructed out of struggles involving appropriation for profit (Lefebvre 1991: 384). Representational spaces overlay physical spaces with historical and cultural symbols. It is the space of the imagination sometimes '*linked to [the] clandestine and underground side of social life, [and] also to art*' (Lefebvre (1991: 33)

Type	Physical space	Mental space	Social space
action/space	Perceived space	Conceived space	Lived space
result	Spatial Practice	Representations of Space	Representational Space

Table 1: Lefebvre's spatial triads. Each column shelter characteristics for distinct moments of the same social moment, called generically Social Space.

Since the concepts of '*practiced*', '*conceived*' and '*lived*' spaces correspond to 'moments' in the same space, that is, the same social space, events that are the same could be regarded as providing different meanings (Elden 2004). For example, a situation such as the arrival of a man in his office could be analysed in terms of mathematical data - the height of the man, the length of a corridor, the number of doors, and so on; making use of a second perspective, it could be analysed in terms of body movement - the man's walking about and his gestures, the limitations imposed on his behaviour by his being at the office; and via another, his inner subjectivity - his feelings about a stupid doorknob which does not turn, for instance. In other words, the concepts of '*practiced*', '*conceived*' and '*lived*' space are overlapping, not juxtaposed on one another.

Lefebvre's spatial interpretations can be interrelated to IT and will probably help us get closer to the objectives of this section. Erik Conrad (2006), suggesting an analysis of Lefebvre's concepts about social space in the light of IT, mentions that the '*practiced*' space, which comprises the actual routes and networks that organize the daily routine, is ultimately where the effects of ubiquitous or pervasive computing design will be felt and internalized, evincing that computing is part of the infrastructure that organizes daily life. Conversely, it is possible to suggest that this is the instance in which IT would be most clearly committed to ideological intentions and be expressed as the power to dominate society (Castells 2000) .

Through this '*conceived*' space, representations are used by scientists, architects, urban planners and all of those who privilege the cognitive over the perceptual, creating a mental space separated from physical space, or an abstract space imposed on concrete life. Conrad (2006) mentions that this is the dominant space in society, and is the space belonging to contemporary visual and computing cultures. Again, reversing Conrad's ideas, it is easy to associate it with the tradition of '*ocularcentrism*' in western culture (Levin 1993; Pallasmaa 2005) and all derived problems that come from privileging one bodily sense over the others.

Finally, '*representational space*' is directly lived through its associated images and symbols, being the passively experienced space which overlays physical space. As '*representational spaces*' tend to be more or less coherent systems of non-verbal symbols and signs, embodied interactions of computers with users move the design of computing systems from '*representations of space*' to elements of '*representational space*', from *'conceived'* to *'lived'* space.

According to the understanding provided by Conrad (2006), Lefebvre's arguments seem to imply that the triads are in some way analogous, although different. If social space reconciles the duality of the mental and the physical with a nature that is both abstract and concrete, one may also argue that representational space holds a similar position between '*spatial practice*' and '*representations of space*' just as the *'lived space'* does between the '*perceived*' and *'conceived'*. If all interactions with computer systems are social, and the social is the space of embodiment, where mental physical and mental co-mingle, this is the location in which embodied interaction will operate. According to Conrad (2006), the layered interfusion of spaces presented by Lefebvre provides a rich framework for thinking about the possibilities of embodied interaction as it extends into everyday space while simultaneously reflecting the embodied interaction's careful negotiation between technology and the human being.

It has been seen that the approaches about IT and the environment present a distinction between universal computing, the meaning of which is normally associated with the '*metaphorizations*' mentioned by Graham (1998), and the efforts to situate, in a very concrete manner, computing in the environment. Those latter efforts led to the understanding of social space as one that is able to provide reconciliation between physical and mental space, unifying the embodiment process of perception and conception in what Lefebvre called *'lived space'*. This has also clarified the potential reconciliation between practices and corresponding representations of space via representational space, which Conrad (2006) suggested as the location where embodied interaction design could provide fertile ground with respect to the reciprocity between computing and the environment. The task here is to outline a framework in which IT could be studied through its physical presence in the space, a presence which could be embedded or not, but interfering over that lived space too. To do so, an IT device will be analysed as a system of gears in Chapter 2, in an attempt to establish correlations with the lived space. However, before moving on to the framework itself, this chapter should end by summarizing the discussion about the crisis of the mechanist model of information in the sciences, then moving on to explain an alternative way of regarding information as a spatial phenomenon. This is what is discussed in the following sections.

1.8. Information and the rationalistic tradition

It was mentioned previously that a mechanist model supports the traditional understanding of *information* and, consequently, of communication processes. That model is based on the idea of Shannon and Weaver (Shannon and Weaver 1949) reflected in the formula Source-Message/Channel-Receiver. In all models derived from this, communication becomes reduced to a question of transmitting information, and the implications of this will be considered in other stages of the research.

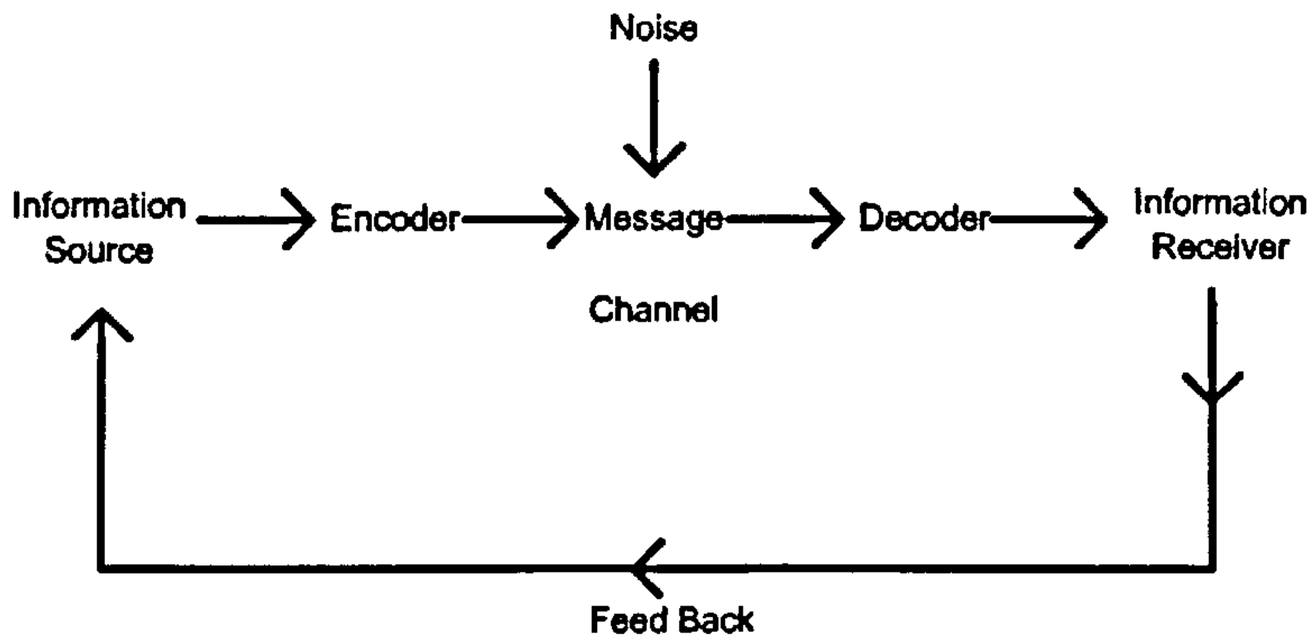

Figure 2: The Shannon-Weaver Model of communication (1949) with the inclusion of feedback to suit the model to human communication.

All the distinctions generated by this model (emitter, encoder, receptor, channel, message) are suitable for establishing separate entities that permit mathematical descriptions and quantifications. Mathematical models and probability studies support this model, enabling it to explain, describe and prescribe a wide range of related phenomena.

This model is said to be '*mechanist*' in reference to '*mechanism*' in philosophy, which is the doctrine according to which natural reality is deemed to have a structure that can be comparable to the structure of a machine, in order to permit the development of explanations based on machine models only. The mechanist vision is part of a long tradition in western culture that will be called the *rationalist tradition* and it is this tradition that serves as a basis for the culture's commonsense understanding of language, thought, and rationality, and which will be briefly discussed in this section.

Nowadays, the mechanist model of communication has many critics who support other approaches. The main criticism is that this model is a *conduit metaphor* of communication, which in reality cannot contribute to the understanding of human communication. People in fact require much more complex types of relations, and, consequently, models in order to understand how they communicate: they create, for instance, all sort of contexts through which messages can acquire different meanings depending on the relationship between emitter and receptor, their intentions, their previous common history, and so on. Therefore, the mechanist model can be regarded as only an expression of a 'distortion' caused by the rationalist tradition.

At least half of the book by Terry Winograd and Fernando Flores entitled '*Understanding Computers and Cognition*' (Winograd and Flores 1988) is dedicated to the crisis originated from the adoption of the rationalist model to explain the phenomenon of information in the sciences. In

order to permit a fair summarization of the topics without extending the section into the realm of philosophical minuteness that is so often penetrated in the related literature, reference to those two authors will be indispensable to this revision. To Winograd and Flores (1988) the rationalistic orientation has been the mainspring of western science and technology, and has demonstrated its effectiveness most clearly in the '*hard*' sciences that explain the operation of deterministic mechanisms whose principles can be captured in terms of formal systems. The tradition finds its highest expression in mathematics and logic, and has greatly influenced the development of linguistics and cognitive psychology.

Roughly, the rationalistic tradition can be traced back at least to Plato. The way Greek philosophy postulated the conception of the reality was two-fold, based on what the 'real' could inform the human senses and permit to be perceived in experience, or what could be grasped by the rational operations of the brain concerning reality. From the former derived all the empirical approaches in the science, and from the latter, rationalism itself. In modern ages, with the work of the French philosopher Descartes, the rationalist tradition was dissociated from the Greek religious orientation that argued that, since reality was given by data provided to one's brain, it was outside the temporal realms and, therefore, eternal. Correcting this '*mistake*', Descartes methodically separated the concepts of *soul* from *body*, and *subject* from *object*, creating a philosophy based on extension and quantity. The evolution of the rationalistic tradition has developed along the course of Western history, influencing a large variety of fields, among them the study of *language* and *cognition,* and providing a *rationalistic conception of information*.

The main criticism of the point of view of the rationalistic tradition is that, like empiricism, both stress the necessity to separate subject and object in order to create the means though which reality can be understood. Both make a distinction between a subject, who senses or thinks, and the reality itself, which is sensed or thought. But in both cases, that reality is an object the representation of which by ideas or sensations constitutes a frozen aspect of the wide range of things that the reality really comprehends. The problem of this division is that, like any other dualism, it is a reduction and does not explain many complex problems concerning complex conjunctions of realities. The *real* itself is negated, being dynamic, changeable in time, being thus incorrectly depicted as a frozen vision of the world.

All aspects related to the dynamism reality will not be grasped by the communication model of the rationalistic tradition. Among other things, it will be found impossible to study aspects by which that dynamism that present itself in the idea of information itself, for example language and cognition. The rationalistic tradition regards language as a system of symbols that are composed into patterns that stand for things in the world. Sentences can represent the world either truthfully or falsely, coherently or incoherently, but their ultimate grounding lies in their correspondence to the states of affairs they represent. Also, the assumptions behind the idea of cognition are that all cognitive system are symbolic systems and as such it achieves its intelligence by symbolizing, and representing external and internal situations and events, and by manipulating those symbols. Finally, and particularly concerning this research, the abovementioned representational problem proposes that information can be only related to the spatial components of the place representing a meaning inside culture. As has been assumed here, the attempt made in this bibliographical review is to permit us to regard spatial elements as information itself, in other words as having the same pattern as a communicational situation that belongs to a more complex phenomenon.

In short, the adoption of that model for this research would not help in the creation of a framework, since it does not offer enough elements to explain correlations between the concrete elements of a place and the information. The studies of semiotics applied to architecture can be regarded as an attempt to understand physical space as such a communicational phenomenon, but those studies derived from the same rationalist tradition through which the problem of representation inside the model of communication is still relevant.

For instance, through semiotics, a spatial element should be considered as the conjugation of a signifier - its physical characteristics - with a signified - its meaning inside a cultural repertoire, that means, a sort of reservoir of paradigms to understand spatial elements as meaningful signals. The correspondence between signifier and signified are established through a cultural agreement, and an ideological background which supports all the representations to the correspond one to another, space and its cultural significance. In section 4.5.1 on page 96, the idea that the distortions of such representations should be considered in terms of the analytical method, at least in order to establish a dynamic way of considering the problems that such representations bring, will be discussed. The semiotic methods applied in architecture (for example, those presented in Baudrillard 2005; Eco 2005), however, revealed their relative effectiveness when used to criticise final results, rather than to disclose more about the reality within which a project should be created.

1.9. Another paradigm to regard information

It is now a good moment to summarize what has been seen so far in order to synthesize a conclusion about what has been discovered about information and space in this review of the literature. First, the meaning of the term '*information*' was examined, showing that it underwent a process of dematerialization in many fields just after the Second World War. Gradually the term lost its concrete references to everyday life, and it began to comprehend the sciences, the various technologies and society itself. In an effort to understand the relationship between the type of sciences where '*information*' is involved and the relative social context, it was observed that '*information*' could be treated, on one level, as emancipation from political power, and from simple meaning until its functional objectification. Thus, many authors where classified as having a adopted specific way of considering information, either referring to its political potential to emancipate society, or considering it only in terms of its functional bias, as a simple object. Therefore, how information technology is regarded to act on society has been studied by analysing how information and technology can be associated. . It has been seen that IT is sometimes considered a strength that can mould and transform society, and by other authors sometimes it results from the social changes themselves. Yet other authors lay claim to a vision through which IT and society interfere mutually with each other, observing these mixed contributions from new paradigms within philosophy. In continuation, it was studied how IT could interfere with concrete space through the analyses of the way some authors refer to its technological consequences. Thus, IT was regarded from the point of view of the substitution of the real by the virtual space and its eventual recombination within the social context. Attention was paid to the point of view of Lefebvre, who introduced a triad in order to understand the relationship between physical space, mental space and social space by conceptualizing three types of overlapping spaces: *practiced, conceived* and *lived space*. Finally, a section was dedicated to observing that that variety of ways to deal with the relation between space and information – many contradictory - was a result of a rationalistic tradition that accepts a model of communication based on the metaphor of a physical conduit. Despite the popularity of that model and its functional acceptance in many fields, the necessity to find another model of communication that can explain better the relations between spatial elements and information was observed. Finally, in this section, a new paradigm to that model will be introduced.

It was observed in the last section that Terry Winograd and Fernando Flores (Winograd and Flores 1988) introduced an extended discussion about the backlash to the adoption in all fields of knowledge of the rationalist tradition and the associated mechanist model of communication.

Aiming to create a contrast between new paradigms and that tradition, they discussed alternatives to that point of view, focusing on big themes such as *hermeneutics, ontology* and *cognition.* In particular they introduced the insights of the Chilean neurobiologist Humberto H. Maturana as a new paradigm in the study of cognition. Maturana, most widely know for his work on the neurophysiology of vision, is a biologist, rather than a philosopher, and he deals first and foremost with the nature of biological organisms as *mechanistic structure-determined systems.*

In terms of his contributions to the study of cognition, his original work is studied in order to provide a comprehensive view of the phenomenon of communication, focusing specifically on the view that the environment is a space that permits communicative interactions with living systems that are dwelling in it. Those interactions can be regarded as a type of linguistic order, and, therefore, permit relevant ideas about the relations between information and space to be observed. This section will end by introducing a brief commentary on his ideas in order to come to some conclusions about the model of *environmental information.*

According to Maturana's biologist point of view (Maturana 1980), living systems are open to matter and energy; but at the same time they are operationally closed - that is, closed to information or instruction or control. They run themselves, according to their own rules, but at the same time are absolutely dependent on their connection with the medium in which they live, which provides their source of their material existence. Their structural malleability, called plasticity, is the extent to which they can adapt themselves structurally to survive within the environmental disturbances. Their survival will depend upon their internal structure, such as the domain of potential behaviours that can be triggered by disturbances and establish new states, as well their ability to preserve the history of their structural adaptation in new patterns.

The concept of information adopted by Maturana to explain the relations between living systems and their environment is different from one regards that information as something that conveys symbolic representations of the world, transmitted from an emitter to a receptor. Instead, information is regarded as all manner of disturbances through which the systems coordinate their performances (behaviours) in order to generate consensual and cooperative actions to support themselves. In this sense, information about the environment amounts to a level *environmental disturbance* that triggers internal and structural modification within the living systems resulting in new states of balance (Maturana 1978).

Living systems that have those attributes generate communication. Communication is, therefore, the coordination of behaviours or their mutual triggering amongst members of a social unity. It is a two-way system, in which each side, when disturbed by the other, changes itself with reference to the other in a series of coordinated modifications in order to support themselves or to re-orient their behaviour. This communicational process depends upon the determined, malleable and closed organization of living systems and it can be either instinctive (philogenic, structurally given) or learnt (ontogenic, preserved as the history of the structural changes of the system according to its malleability). As such, behaviours that are kept over many generations may be called linguistic behaviours. Together, linguistic behaviours constitute a linguistic domain of a social unit. In other words, linguistic behaviour is the ability of a system to plastically coordinate itself in order to cooperate with other systems, and cope with disturbances from the medium.

If the medium (environment) can be also considered as a structurally plastic system, then the two plastic systems may become reciprocally structurally coupled through their reciprocal selection of plastic structural changes during their history of interactions (Maturana 1978). In such instances, the structurally plastic changes of state in one system become perturbations for the other, and vice versa, in a manner that establishes an interlocked, mutually selecting and mutually triggering domain of state trajectories. The structural correspondence between the medium and a given living

system is always the result of the history of their mutual interactions, while both operate as independent, structurally determined systems:

> *"Adaptation, then, is always a trivial expression of the structural coupling of a structurally plastic system to a medium. Adaptation always results from sequences of interactions of a plastic system in its medium that trigger in the plastic system structural changes or changes of state that, at any instant, select in it a structure that either matches (is homomorphic to) the structure of the medium in which it operates (interacts or behaves) as such a system, or disintegrate it. It follows that, in the operation of living systems as autopoietic unities in a medium, the coincidence between a given structure of the medium (place in the medium) and a given structure in the living system is always the result of the history of their mutual interactions, while both operate as independent, structurally determined systems. Furthermore, as a result of the structural coupling that takes place during such a history, history becomes embodied both in the structure of the living system and in the structure of the medium, even though both systems necessarily, as structure-determined systems, always operate in the present through locally determined processes."*
> *(Maturana, 1978: 38-39)*

It could be considered here that the coincidence between the environment and socials unities derives from the same coupling.

In light of the concepts just outlined, it is possible to regard information, as a concept used in this enquiry, as those perturbations that trigger structural changes in living systems and in the environment, recursively. When systems are coordinated in mutual cooperation to achieve a new state of balance with the environment, they promote changes (termed '*behaviour*' by an external observer) in their structures and this process constitutes a *linguistic behaviour*. To an external observer, the changes in the environment will be regarded as a result of that *linguistic behaviour*, and it will be possible to distinguish that *'universe'* of disturbances as a linguistic domain.

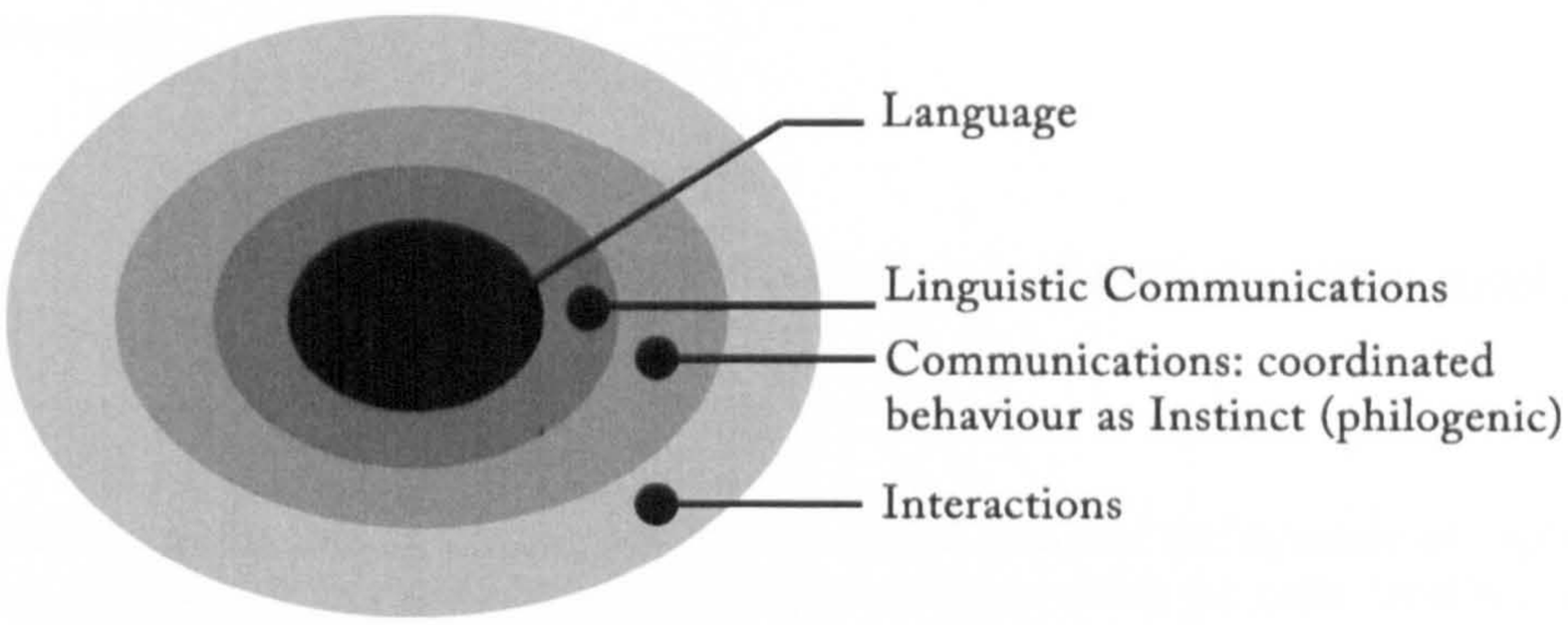

Figure 3: Linguistic domains in the interactions of a system with other systems and with the environment

For those latter concepts it can be said that the linguistic domain of a system is the *'universe'* of interactions that originates from disturbances occasioned by other systems, including the environment. Thus, it is possible to infer that the actual state of the environment and the history of its plastic transformations can be regarded as part of the *linguistic domain*. Therefore, the ability of a system in making spatial modifications and changing the environment to survive can be understood as a particular kind of communication behaviour, specified through spatial interactions. If the spatial environment is regarded as a system which can disturb others, the same can be said about it, which means that its changes result from disturbances that are a particular process of

communication. Thus, it is possible to characterize a probable function of information so as to trigger spatial changes reciprocally and recursively in the interactions between environment and the systems that dwell internally. At the same time, once the environment regarded as medium is disturbed and modified, it can be said that this is also communication. This does not mean, however, that space conveys information but rather that *space is itself information*. Since spatial environments are coupled with the behaviour of the systems that live in them, and vice versa, as the result of preceding spatial disturbances, space both recursively disturbs and is disturbed by the systems.

With regard to this dynamic communicational process in macro systems, it can be said that human spatial behaviour disturbs the environment whilst simultaneously being a *result* of disturbances from that environment. When an environment is coupled with the processes of human life, they are able to establish a domain of interactions that permit communication in order to carry on their related activities. Human spatial behaviours include the tool making skills that mean that those behaviours can be described as actions directed at adapting and transforming materials and spaces in line with their corporeal relations through the use of various kinds of equipment, in order to cope with the environmental disturbances. It will be seen that architecture and the architectural space can be regarded in terms of these abilities, and they can be also considered as kinds of equipment themselves. This process and the resulting transformations belong to a linguistic domain, which is tantamount to saying that the ability to make equipment and the tools resulting from that ability comprise the communication established between the systems in order to react to the disturbances (provoked in and by each other), thus creating a domain of coordinated and mutual actions.

Put simply, on Maturana's point of view, the concrete presence and physical characteristics of spatial elements present in the environment are the very disturbances from which interactive behaviours aimed at adapting the dwelling systems in that environment spatially are originated. They are recursively interfering, which means, the physical elements of the environment and the activities in their internal dwelling systems modify each other in order to create a space of concrete and co-operative interactions. That space can be regarded, at the same time, as a linguistic domain – which comprehends the former ideas of information - and as the concrete spatial organization of that environment.

1.10. Topology of information and space

It has been said in the section 1.2 on page 16 that Floridi analysed the dynamic of '*information*' classifying the ways it is related to a general phenomenon which he calls '*reality*'. Thus, he mention that those relations can be as '*information as reality*', '*information about reality*' and '*information for reality*'. In fact, Floridi advocates that '*information as reality*' or *ecological information* includes even the studies of Shannon's *Theory of Information*, once that theory is a sort of concern with information as the presence of physical elements which are neither true nor false. It means, elements that are not interpretive. As it has been mentioned, to Shannon theory, meaning is out of concern, that means he reduced the study of communication to the analysis of the transmission of messages without the concern of interpreting them. The same can be said about the model of information developed through Maturana's point of view, in this research: it has the dynamic as '*information as reality*', and it includes non interpretive elements.

In conclusion the model developed in this inquiry understands information in the environment as a result of disturbances that exist among the internal dwelling systems and which adjust themselves

towards adaptation with each other and the environment itself. Far from assuming an interpretive content, in architecture, the elements of such *ecological models of information* correspond to those formal elements that are the atoms through which meanings are realized in terms of space. The revision of terminology used by some authors as Norberg-Schulz (Norberg-Schulz, C. 1971; Norberg-Schulz, C. 1980), Christopher Alexander (Alexander, Christopher *et al.* 1977; Alexander, Christopher 1979) among others has permitted the representation of the spatial structure of information in a place as being organized on the basis of the following elements:

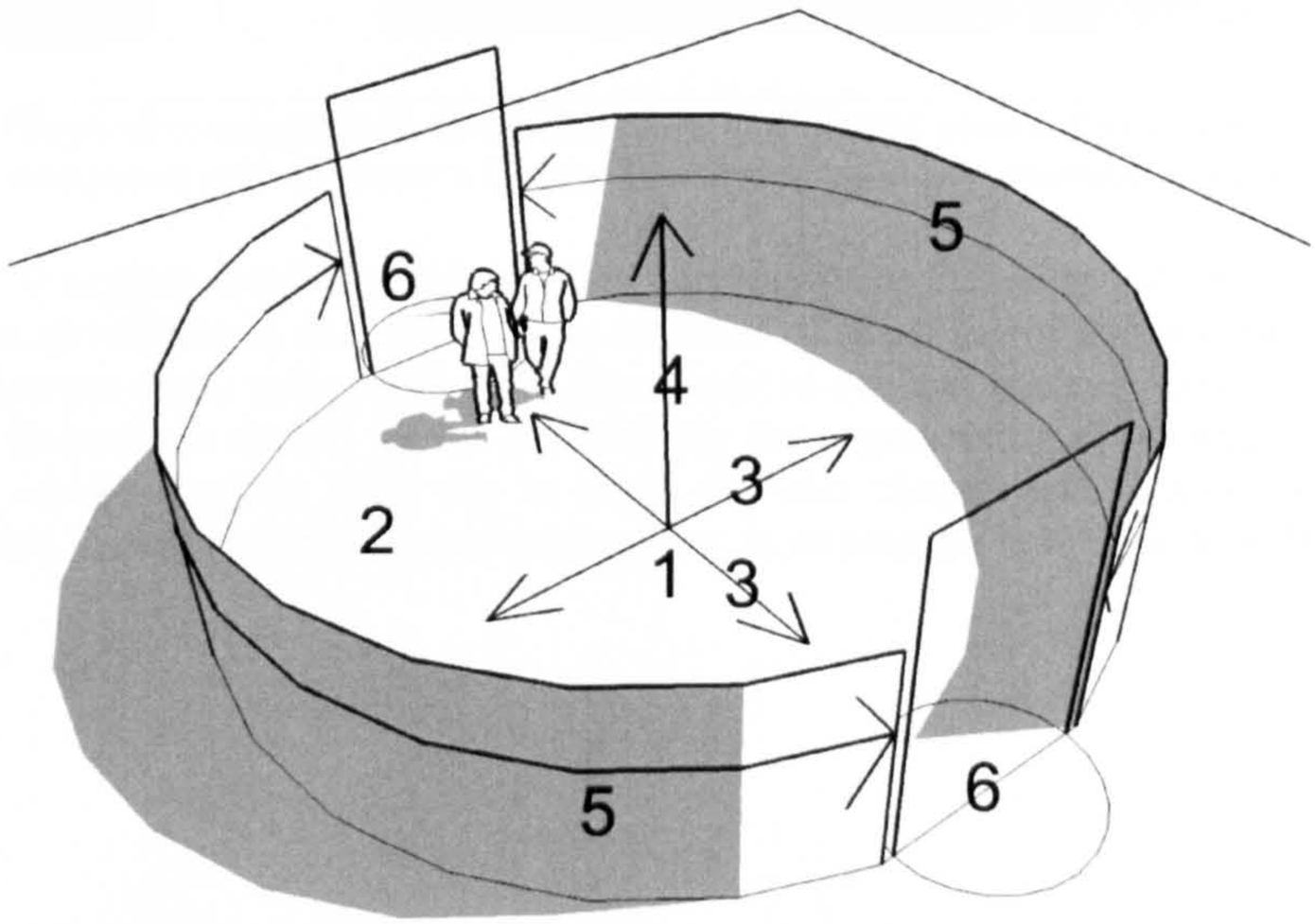

Figure 4: Spatial Structure of information and elements of the place.

1. Central point (centrality)
2. Internal area;
3. Horizontal directions;
4. Vertical directions;
5. Enclosures;
6. Entrances.

It will be seem that those elements can be understood as events that unify spatial elements and the activities that happen in a particular place, according to the topology shown. Basically those elements correspond to the general descriptions mentioned by the authors discussed in reference to the interpretation of the meaning of architectural space. This means that those structural and topological elements do not have unique and fixed associated meanings, but they are counted as general supports for the entire universe of possible interpretations. This inference is made possible by the topological aspect, which specifies only the relative positions of elements instead of their geometrical properties. For example, an entrance can be described as information, in such model, since it is *the connection* with the outside. This definition does not imply any meaning, and neither does it specify whether it is a '*main*' or '*secondary*' entrance, or has any other possible meanings associated with '*doors*' and '*transitions*' to the external spaces. An enclosure can be described as the '*envelopment*' of the central area, and the central area is formed relative to the involucres of the facades or walls or other '*events*' interpreted as enclosures. All the interpretations of this model relate to general aspects of the spatial elements of the place without any special remarks being related to the meanings. To a certain extent, this model permits the comparison of structural and generic aspects from different places, as is suggested illustratively in Figure 5.

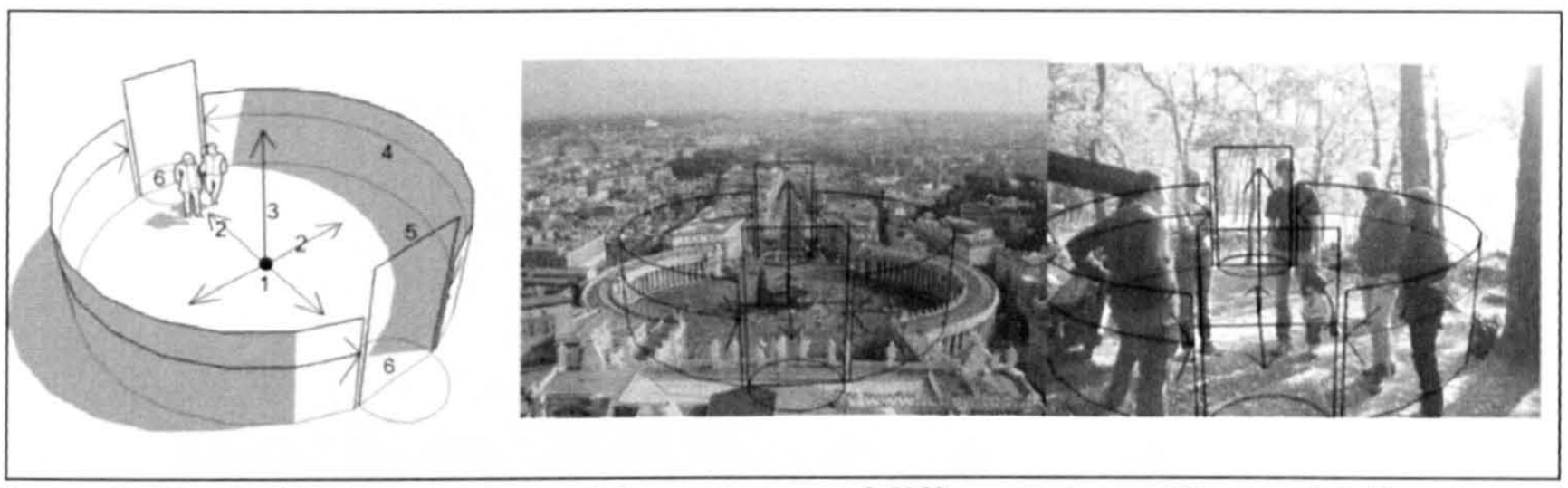

Figure 5: Illustrative comparison of the structure of different places. The model, the elements interposed over St. Peter's Square (Vatican) and over a meeting in a park.

Once a model to explain space and information simultaneously has been achieved, it is possible to move on to the development of a framework. In order to detail the relations between information and spatial elements when technologies are introduced to connect the activities that happen inside the place, the framework should justify qualitatively the organization of information in the space when used to assist a project. With this in mind, the next chapter will address attention to how space is qualified in order to transform it into a place, in an attempt to deduce how IT could support this process.

Chapter 2:
Development of a Framework
Part I: Place

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At the beginning of Chapter 1 it was pointed out that the bibliographic themes of this thesis were structured by the initial key research questions. An initial speculation about the type of theoretical approach that could support the design of IT for urban spaces resulted in a study of the correlations between *information*, *technology*, *space* and *society*, and the mutual influences at work between the technological expression of IT and the social life were observed.

In an attempt to construct a framework based on the correlation between IT and space, by the end of Chapter 1 the definition of information was revised in the light of Humberto Maturana's theory and his thoughts concerning biological cognition. In the context of that theory, information could be interpreted as patterns inside the broader phenomena called '*disturbances*' that occur in systems. In a process of adaptation to those disturbances, different systems adjust themselves to each other through structural coupling, thus creating co-operative patterns of behaviour.

That process of adaptation will in turn be reflected both in the environment and in the systems involved, and could be regarded as the concrete expressions of the co-operative interactions that take place in and among the systems. This is regarded by Maturana as a species of phenomena related to the linguistic domain. That new concept unveiled the possibility of interpreting the very physical structure of place as a topology of information, since the spatial elements and the related activities have come to be equated to a concrete expression of the phenomenon of communication.

Now, the key questions will again give a direction to the development of a theoretical framework. Following on from the question of what theory about the use of IT in urban projects would be the basis for a valid approach, the next question concerns the types of correlations that could be created between the spatial elements in the place concerned and the digital technologies components. The hypothesis is that it is possible to regard the use of Information Technology as a means of improving urban architectural spaces qualitatively.

Thus, both this chapter and the next will address themselves to connecting a set of concepts in building up that framework. Firstly, a theory about place will be examined, and its qualities and correlations with spatial elements will be characterized. Next, a method of identifying conflicts between activities and those spatial elements will be introduced. Then, in Chapter 3, Information Technology will be described in terms of its components and they will be correlated to the qualities of place, leading to an analysis of how they could support people's activities. By classifying the digital technologies components in terms of their functions, how those functions could support spatial characteristics by facilitating more interactions will be studied. Consequently, digital technologies components will be correlated to the qualities of the place. Finally, a method of

supporting the creation of Ubicomp systems by utilising the synoptic tables compiled for this framework will be presented.

Some final considerations should also be made in order to justify the characteristics of this framework. Firstly, in order to improve the impartation of the framework to architects, its subjects were originally divided on the basis of two points, focusing on '*place*' and '*IT in the place*'. That division corresponded to the two phases with respect to two distinct points in the development of the framework from 2006 to 2007. That division was preserved here in order to emphasize the organization of the case studies and, at the same time, to permit a final evaluation of the adopted theoretical apparatus regarding place, as it will be seen in Discussions and evaluations in Chapter 8. For this reason, the framework will be presented in two chapters addressing those two originals concerns, Chapter 2, addressing the development of a theory for understanding information in the place and Chapter 3.

Secondly, it is an attempt to create a theoretical approach covering two distinct fields: Information Technology and Architecture. However, both fields have been significantly influenced by the evolution of technology. Therefore, for the reasons outlined in the introduction to this thesis, the unification of some principles regarding the creation of Ubicomp is a task for systematic research. Furthermore, it is considered essential that the framework should be tested by its users and refined after an evaluation of the outcomes as generated by the test users. For this reason, the framework in its present form should be considered to be the outcome of the revisions that took place after the three case studies presented in Chapter 5, Chapter 6 and Chapter 7. However, the current version of the resultant theoretical framework is subject to further tests and refinement.

Thirdly, some concepts were chosen in light of my personal experience, which was a starting point to the theoretical development. In my previous experience as a research investigator in the *Universidade Federal de Minas Gerais* School of Architecture, I employed the concepts of place described by Malard (1992) in some of research works in which I collaborated, evaluating housing and urban areas in Brazil (Souza, Renato C. F. 1998). Malard derived her main arguments from the ideas of Heidegger concerning ready-to-hand objects (Heidegger 1962) and the nature of dwelling (Heidegger 1975). This chapter contains an account of the framework developed by her, discussing her initial concepts of place and the derived methods. In the conclusion to this thesis, on page 190, the results from the adoption of Malard's approach will be discussed along with other ideas for future research.

Finally, the framework presented through this research has been revised on three occasions as a result of the tests carried out. It still has shortcomings which suggest that more research needs to be done. The need for concise referencing to different theories has delimited the space available for elucidating them in terms of how they could be unified through the context of this framework. To remedy this, only bibliographical indications were left in some places in order to leave open the possibility of providing further explications of those theories. Despite the deficiencies in the framework's texts caused by the constraint, it has permitted the handling of diverse range of theories in the composition of a framework accessible to architects and urban designers.

2.1. IT gearing the environment

The concepts put forward by McCullough (2004), describing the components of a general IT system and relating them to space, are useful in arriving at a concise understanding of the relations

between the digital technologies components and the environment. McCullough initially comments that in the last few years ambient, haptic and environmentally embedded interface elements have become viable and require more concern for the physical context. In criticizing the design of desktop computing, he mentions Don Norman (1998: p.69) for whom prolix technologies and confused interfaces resulted from poor designs that ignored new forms of locality and context. Norman calls for '*invisible*' computers reflecting the need for less attention-demanding technology, echoing Mark Weiser's vision (Weiser 1993) and reflecting Heidegger's ideas on '*equipment*' (Heidegger 1962).

For Heidegger, *equipment* refers to the essence of objects when their natural characteristics are transformed into tools by the application of labour. When items of equipment function well, they disappear from human consciousness into the background of everyday life, and are only noticed again when a breakdown occurs. Heidegger used '*equipment*' to express an idea of the 'gear' of the human world that supports existence. Thus, two apparently opposed concepts are advocated by IT evolution: one is the localization, which means the meaningful consideration of localities to interactions and the other is the '*equipmentability*' of digital technologies components as gears that are needed to support tasks without being noticed. In one way, it requires the appearance, the location, in other, the disappearance, and the ubiquitous. IT gears need to disappear into the environment by becoming equipment in the sense implied by Heidegger. On the other hand, that gearing needs to consider the physical characteristics of the place and the dynamism of the connections with other localities.

If we view analytically *connectivity* and *equipmentability* as a dialectical pair of concepts in the terms provided by Lefebvre's (1991), connectivity means a spatial practice required by the physical space, whereas the equipmentability means the transformation of that practice into a procedure to support the social space, conciliating the external world with the symbolic codification of lived space through the representational space. That disappearance, thus, is much more related to a transformation of the presence of IT gears into representational elements in the lived space than an absence itself. The disappearance of digital technologies components means that they have achieved a state in which they are transformed into the symbolic elements of lived space, elements around which humans are able to establish symbolic references and inside which they are able to dwell. The *'universe'* considered here is that of a dwelling's symbolism from which the spaces are studied as places that reveal their characteristics and qualities.

In light of the new possibilities mentioned by McCullough, questions about how to move from graphical user interfaces to inhabitable interfaces where connectivity is essential are now central to the field of computing. The first concerns the use of everyday objects and spaces as interfaces for computational resources evolved over the course of the last twenty years, from home interiors to urban space exteriors, facilitating the rise of Ubicomp as a potential solution to many problems that affect a massive number of users. Building on the preoccupation with qualifying places in the outdoor world, Ubicomp can be an alternative solution to problems in the urban scene when it is assumed that public spaces can be qualified for dwelling. Understanding '*dwelling*', then, and the other related concepts of place, seems to be the starting point for the construction of a theory connecting both information and space, and IT and place

2.2. Equipments to dwell

As mentioned before, Heidegger (1962) made an interesting investigation into the way we consider objects in the world, and in light of this it is possible to broaden our understanding of the term

'*equipment*'. He thought that our everyday conscious experiences of the world are not experiences of the intrinsic natures of the objects around us. Instead, they are typically concerned with using objects to achieve some goal. According to Heidegger, the objects in the world are:

- *Present-at-hand Objects*: These are material (natural) objects. When the question '*what is this for?*' is asked, the answer will be: '*this is for nothing; it has no specific purpose*'. For example, a stone is just a stone. *Present-at-hand Objects* are found in nature in their natural state, and they have specific properties that define what they are. It is only when one uses labour to transform them, that they acquire new attributes and become new kinds of material. A chair is for sitting on, but the wood that a chair is made from is only the wood itself; it is for nothing, and has no particular purpose. The wood is a present-at-hand object, and the chair is a ready-to-hand object.

- *Ready-to-hand Objects*: utilitarian objects. When you ask, for example, the question '*what is a hammer is for*', the answer will be: '*a hammer is for hammering*'. As the name of the object suggests, it is made for a specific purpose, and its meaning is only valid inside a set of cultural assumptions.

Ready-to-hand objects have attributes and qualities beyond those that come from the materials they are made of. In fact, they are '*equipment*'. Therefore, in order to know the essence of the item of equipment, one needs to ask: '*what is it for?*' and the answer that comes up will be the essence of the equipment. The significance of particular pieces of equipment can only be gauged through comparison with other equipment. The totality of the equipment makes sense of the individual item only when it refers to other equipment; the '*in-order-to*' is the structural reference that assigns equipment to the context of other equipment.

Heidegger defines the '*circumspection*' of equipment. This means that we do not make sense of the equipment per se, but rather on the basis of the totality of references in which its meaning is immersed. By being used equipment enters the '*ready-to-hand*' mode of being, becoming transparent – we use it while focused on something else. We experience this mode of being in things when they become unnoticed in the course of our activities with them. Whether at play, at work, engaged in domestic or social activities, we are fully absorbed – in a focal moment, or living life as its best, the world is fundamentally revealed in its '*readiness-to-hand*'. The world, as the totality of references, is the primary *ready-to-hand* entity. Yet as we are always '*in the world*', we simply disregard that basic evidence of our involvement in a significant whole.

2.2.1. Breakdown

Only when something breaks down and is not functioning normally, do we experience some of these relationships coming to the forefront of our attention. If and when equipment is perceived transparently and we find something that does not function '*the way it ought to*' we perceive the equipment as obstructive; we observe that something is missing, and thus we perceive it in a different way from before. When the equipment loses its character availability, we turn our conscious reflective attention to it: we analyse it to diagnose the cause; we observe its properties and characteristics, test it, and so forth. The equipment turns into a *present-at-hand* object (a natural object), and it makes explicit to us that it is this that makes equipment *ready-to-hand* (utilitarian). In other words, the references that make the equipment function in its referential whole become explicit. We discover its unsuitability not by looking at it and establishing its properties, but rather by the *circumspection* (how the equipment disappears from our consciousness and becomes transparent in day-to-day life) of the situations in which we use it.

When *ready-to-hand* entities break down, that to which they refer becomes obvious. When equipment cannot be used, this implies that the constitutive assignment of the '*in-order-to*' to a '*toward-this*' has been disturbed. When an assignment has been disturbed – when something is unusable for some purpose – then the assignment becomes explicit. The context of equipment is lit up, not as something never seen before, but as a totality constantly sighted beforehand in circumspection.

When a breakdown occurs, we stop our activity and begin to reflect on the nature of that equipment and ask questions: '*How is it constructed? For what purpose? Of what is it made? How does it function? Can it be improved?*' Through theoretical reflection, the equipment is revealed in a new way, as something *present-at-hand* (a natural object), as a definitely '*occurrent*' entity (presently occurring). In this situation, our ongoing activity breaks down and we do not just stare at the object, but engage ourselves in a new activity: *theoretical reflection*. The breakdown deprived the equipment of the context, and the context is now a background that enables one to address the equipment in terms of its properties.

2.2.2. Space and place

If we consider space as an object that can be transformed by labour, then it constitutes *ready-to-hand equipment*. As a natural object, space could be described in terms of its physical and chemical properties, but as a utilitarian object, space as equipment can be understood only in terms of its qualities. But, what are the qualities of space? Mallard suggests that when space becomes qualified in order to support human existence, it becomes a particular type of space: architectural space (Malard 1992: p. 25).

A wide variety of definitions of architectural space have existed since Vitruvius. This inquiry however will be concerned with one which is able to explain the dimensions of dwelling. In this sense, Malard (1992) points out that is possible to recognize three dimensions in architectural space which can be interpreted as the means by which the architectural elements are able to provide conditions for dwelling. According to her, dwelling can be provided when the elements of architectural space have a *symbolic dimension, a functional dimension* and, finally, *a technical dimension*.

The *symbolic dimension* comprehends all the meanings humans generate when they organize space in response to the *'universe'* of the human perceptions, emotions and beliefs. At this level, humans give spaces significance and create concrete means of communication among them. In order to essentially understand the symbolic dimension of an architectural space or one of its elements it helps to ask the question '*what is it for*'? The *Functional dimension* refers to the order of things in the space aiming the performance in the activities of everyday life. The question that helps to understand this dimension in architectural places or its elements is: '*how does it work?*' Finally, the *technological level* or *pragmatic level* embraces all the technical knowledge and skills that humans develop in order to create meaningful and functional places. The question addressed in this level is: '*how is this done?*'

Since they have three dimensions qualifying them, architectural spaces will be referred to here as *place*. Then, while space is a general form without specific qualifications to refer to the geometric and quantitative aspects of distances, areas and volumes, place will be understood to be a qualified portion of space: architectural space.

The question now, once we begin to consider architectural space as a *ready-to-hand* object becomes: *what is the architectural space for*? The answer is: '*to dwell in*'. Dwelling, which is synonymous with inhabiting, is a fundamental characteristic of human life; it is more than being

housed, it is being rooted in a calm secure place and belonging to that place. Malard assumes that, in accordance with Heidegger, the house is the place to dwell.

Architectural spaces will herein be referred to as *place*. While space is a general term without specific qualifications referring to the geometric and quantitative aspects of distances, areas and volumes, place will be understood as being much more than a simple matter of specified location. Rather it will be understood as a qualified portion of space: *architectural space*. Nevertheless, there is something that should be taken into account before this concept is examined in the context of urban space: namely, the distinctive characterization of place in Heidegger's thinking.

2.2.3. Place in Heidegger

In his book '*Heidegger's topology*', Jeff Malpas (2007) studied the distinction between space and place in Heidegger's works, with the aim of clarifying the terms used by that philosopher. Malpas concludes that all the terminology should be considered intrinsically related to the totality of the concepts that they are supporting, which amounts to a proper topology of the '*being*'. It was this insight that enabled Malpas to avoid the common and simplistic view that is unable to disassociate Heidegger's thoughts from the particular political and personal involvements of the philosopher himself. Authors such as the geographers and the cultural theorists David Harvey and Doreen Massey have raised many objections to Heidegger concepts of space and place, since they consider those concepts as expressions of the essentially theoretically conservative and politically reactionary character of Heideggerian thought. In short, they come close to suggesting that this putative political character of his though is enough to discredit his ideas about space and place: rather than examining the merits of Heidegger's spatial ideas, the main point for them is Heidegger's involvement with the German National Socialist Party in 1933. However, Malpas has investigated those concepts and has concluded that they only started to appear consistently in Heidegger's thinking after the 1930s, when he left the party; therefore they cannot be regarded as reflects of Heidegger's political association with Nazism.

To demonstrate the complexity of Heidegger's concepts, Malpas (2007) has pointed out that place is a more encompassing notion than space and time, the latter two being presented as complementary modes of dimensionality tied to simultaneity and succession respectively. He observes that one of the difficulties in clarifying the relation between space and place in Heidegger is that not only are the two necessarily connected, but that there has been a tendency for place to be understood in terms that are purely spatial. This means that place is most often treated as either a certain position in space or else as a certain portion of space, formally specifiable in both cases through a framework of coordinates.

According to Malpas (2007) Heidegger worked constantly to evade and avoid the attempt to pin down his language to a simple set of well-defined terms. After the 1930s when Heidegger started using '*place*' directly as one of his themes, then it is place as certain 'gathered' but open '*region*' that is indeed the focus of Heidegger's attention. This conception of place connects, in English, with the way in which the term '*place*' is itself derived from Greek and Latin roots meaning '*broad or open way*', as well with the sense of '*place*' associated with the way in which the intersection of roads in a town or village may open out into a square that may itself function as somewhere people may gather and events take place, perhaps even acting as the centre of the town or village as such. In turn, the English term '*space*' can usually be taken as the straightforward translation of the German term '*Raum*' – a translation that is consistent with most of Heidegger's uses of the term.

In Heidegger's book '*Being and Time*' (1962) the concept of place is dealt with most directly in the ideas of '*Platz'* and '*Gegend'*. '*Platz*' usually refers to a particular place in the sense of location, typically in relation to other things and is a term whose significance is largely restricted to the

specific framework of '*Being and Time*' and the discussion of '*equipamentability*' – namely that '*equipment has its place (Platz)*' (quoted from Malpas 2007). *Platz* invariably refers to place in the sense of location or position, usually the location or position of some already identified and determined entity. '*Gegend*' is often translated as region, and appears in Heidegger' later thinking in order refer to a region as it '*gathers*' a particular place.

Malpas (2007) emphasizes that the idea of place is tied to the notion of '*gathering*' or '*focus*', which is also suggested by the etymology of the German term for place, *Ort*, according to which the term originally indicated the point or edge of a weapon – the point of a spear, for instance – at which all of the energy of the weapon is brought to bear. Inasmuch as this notion of place implies a certain unity of the elements that make it up, so, in Heidegger, it also implies a certain very specific form of '*boundedness*', tied to the idea that what something is to do with its unfolding rather than the point at which it comes to a stop; this suggests a concept of boundary that stresses the idea of *origin* above that of *terminus*. Significantly both this idea of '*boundedness*' and those of '*focus*' or gathering are themselves closely tied to a conception of place that is seen as being constituted through a process of gathering together elements that are themselves mutually defined only through the way in which they are gathered together within the place that they in turn also constitute. This latter feature of place turns out to be a key element in the Heideggerian conception of place.

2.2.4. Urban places

Extending the notion of dwelling to the entire built environment, Heidegger (1975, in "Building, thinking, dwelling") pointed out that even urban spaces are within the realm of the dwelling, since human culture is, existentially, the first location where humans dwell, and after became a built expression of the support to the being. This means that it is not only the interiors of houses that are able to provide the feeling of '*being at home*', but also the external spaces of the urban world. Heidegger exemplified this point by mentioning a driver who feels '*at home*' inside his truck cabin while driving.

Thus, urban spaces can be regarded as spaces in which to dwell, sheltering the *being*. Since the urban space accedes to the position of a set of locations which help humans to dwell (Souza, Renato C. F. 1998), it is reasonable to think that digital technologies components, as long as they participate in the constitution of places, can be understood in terms of the contribution made to *dwelling*; or, in other words, that IT components can be understood as part of *place*. To observe more consistently the qualities of place, it is necessary to consider it as equipment, revealing the roles it plays in the human universe while supporting '*dwelling*'.

2.3. Qualities of Place

Thus, now the task is to describe the qualities of place in terms of human activities. This means, it needs to be described in terms of human existential conditions, i.e. in the simplest way it helps to exist and cope with the world.

Korosec-Serfaty, in the essay '*Experience and Use of the Dwelling*' (1985) investigated the idea of dwelling, focusing on the dweller. She proposed to define three fundamental characteristics of dwelling, which were as follows:

a) setting up an inside/outside;
b) visibility;
c) appropriation.

2.3.1. Spatial ontology

It is possible to understand the aforementioned definitions about place from Korosec-Serfaty (1985) as those initial and founding circumstances which take part in the creation of places. The setting up of an inside/outside is a question of establishing boundaries that qualify space. Dwelling is to be inside (in a place) as opposed to being outside (the infinite space). From this opposition (inside/outside) emerges the characteristic of visibility. Any dwelling can be both, closed or open, visible or concealed, at the same time. Doors and windows make it visible and enable views to be enjoyed from within it. Walls conceal the dwelling but also impede the views that can be enjoyed from it. Appropriation is the process of fully experiencing the phenomenon of dwelling, acting in ways that order the interior and taking care of the home.

These basic dimensions are expressed by subjective phenomena that occur in the dwelling process, that is, by behavioural issues such as privacy, territoriality, identity, ambience and the like. The next step will be to examine how space becomes a place through the human activities that it supports.

2.3.1.1. Setting up an inside/outside

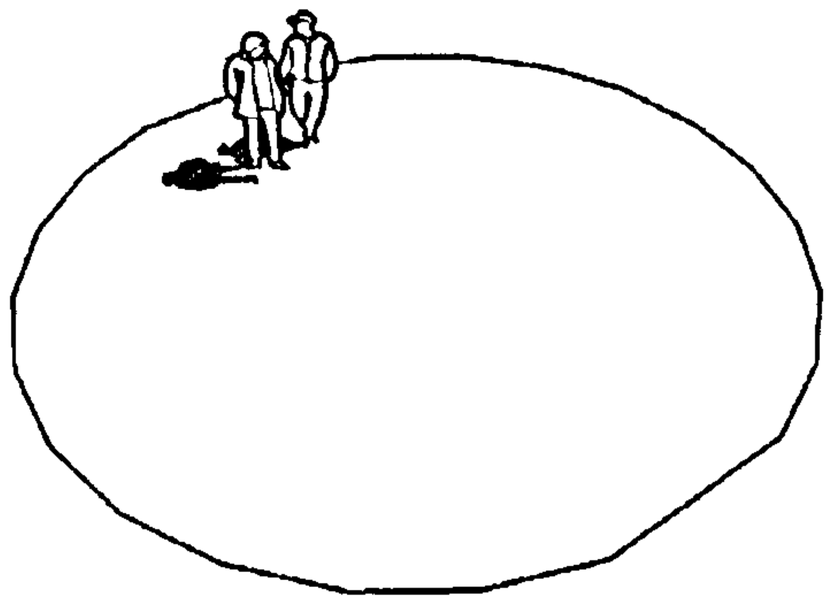

Figure 6: Interior/exterior definition

Korosec-Serfaty (1985) comments that this dwelling's characteristics corresponds to the result of the changes made in the space in order to qualify it and differentiate it as a place. The

differentiation is the process concerning choosing, defining, marking and building places, and it is achieved by interfering with the physical aspects of the place such as, for instance, building walls, positioning signals, indicating the demarcation of limits with spatial elements by means of fences and trees, and organizing the physical aspects of the interior. The qualification of a space corresponds to adding it up with all the spatial resources that enable the activities to be performed better. Therefore, qualification corresponds to the involvement of the place with man's activities.

Korosec-Serfaty comments that the process of the creation of places corresponds to this dual movement which is matter of differentiating the inside from the outside space, and qualifying the portion demarcated in which to perform activities. All built environments, consequently, are submitted to this process of setting up an inside/outside, establishing a territory with demarcated limits, and consequently defining what is private and what it is public. In commenting about the process of creating interiority, Malard (1992) comments that by demarcating and differentiating dwelling places, people put down roots and establish existential connections with them. She concludes that the phenomenological dimension of the dwelling process, which consists of setting up an inside/outside, comprehends the phenomena of territoriality, identity (connectedness) and privacy. Whenever physical elements that enable the definition of outside/inside the place are missing or damaged, a conflict affecting territoriality, identity and privacy is occasioned. Those physical elements grant the separation and qualification of the interior by keeping it differentiated and appropriated to the internal activities, and people will try to overcome the conflicts by providing physical elements equivalent to those missing or damaged.

2.3.1.2. The hidden and the visible

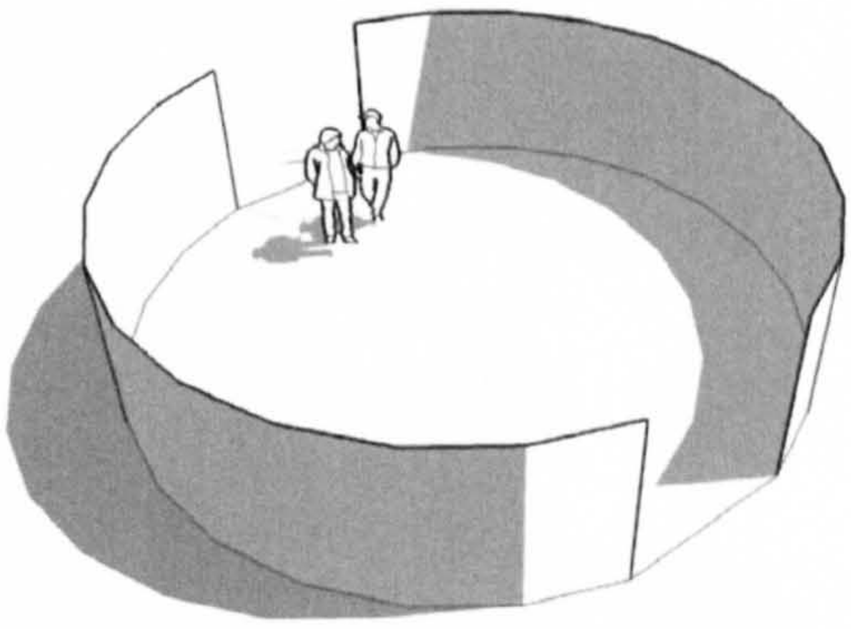

Figure 7: Control of visibility

Once an interior is defined, it corresponds to a definition of what is visible and what is not, thereby correlating interiority with the question of concealing and exhibiting. Since the dwelling is open to the outside and simultaneously encloses the inside, it conceals and shows; it is both secret and on display. This situation leads to the emergence of the quality of privacy and the preservation of identity. 'Privacy' corresponds to what should be kept in secrecy (including sounds and other revealing aspects of the interior), and 'identity' to what must be displayed or shown. Elements such as windows, by their positioning, grant privacy when without leaving the interior on display, whilst simultaneously providing views onto the exterior. When super-exposition of the interior happens,

the physical elements that can control that exposure are revised in order to eliminate conflicts with privacy.

2.3.1.3. Appropriation

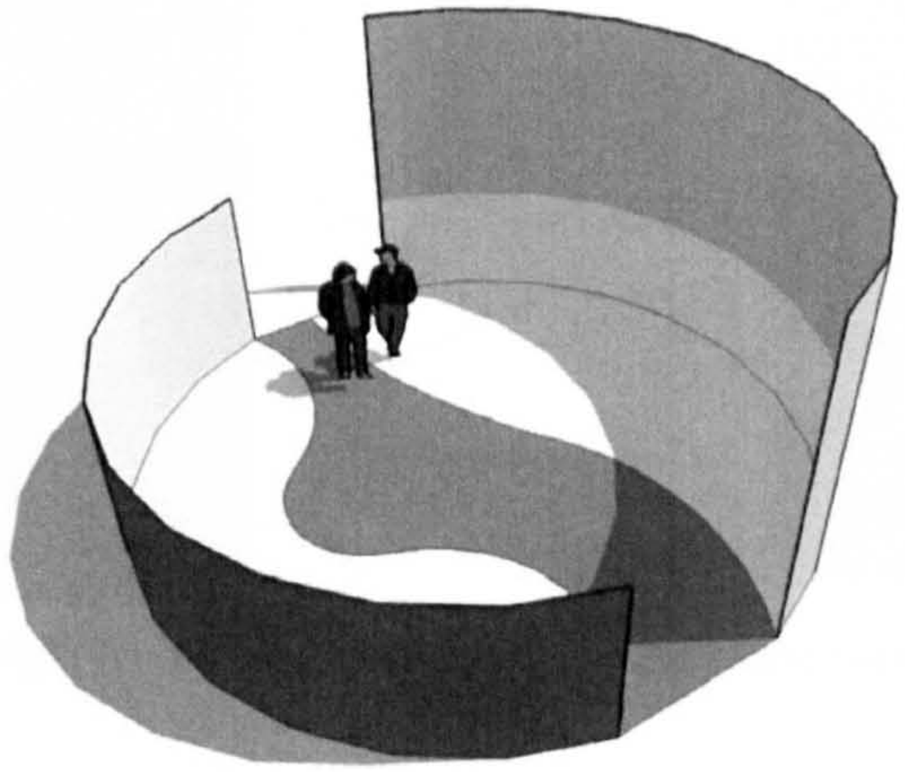

Figure 8: Different internal areas: appropriation

The state of 'appropriation' results from the action of using and taking care of a place; it guarantees that the activities will be performed comfortably, by concerning itself with the maintenance of 'appropriateness', whether by removing rubbish, offering thermal comfort, or providing suitable transient conditions to permit the performance of the activities. This characteristic corresponds to providing people with 'gearings' inside places for the purposes of care and maintenance. Korosec-Serfaty mentions that appropriation is also related to the phenomenon of ambience, which relates to the need to be comfortable while acting and taking care. Almost all qualities of place are, to a certain extent, related to ambience. Nevertheless, in order to be properly appropriated, places need to be comfortable, in terms of the layout needed, temperature, ventilation, illumination and the like.

These three characteristics proposed by Korosec-Serfaty, then, could be said to be encompassed by the four basic qualities that were mentioned:

a) Territoriality;
b) Privacy;
c) Identity;
d) Ambience.

Those qualities will be referred to from now on by their initials 'TPIA'.

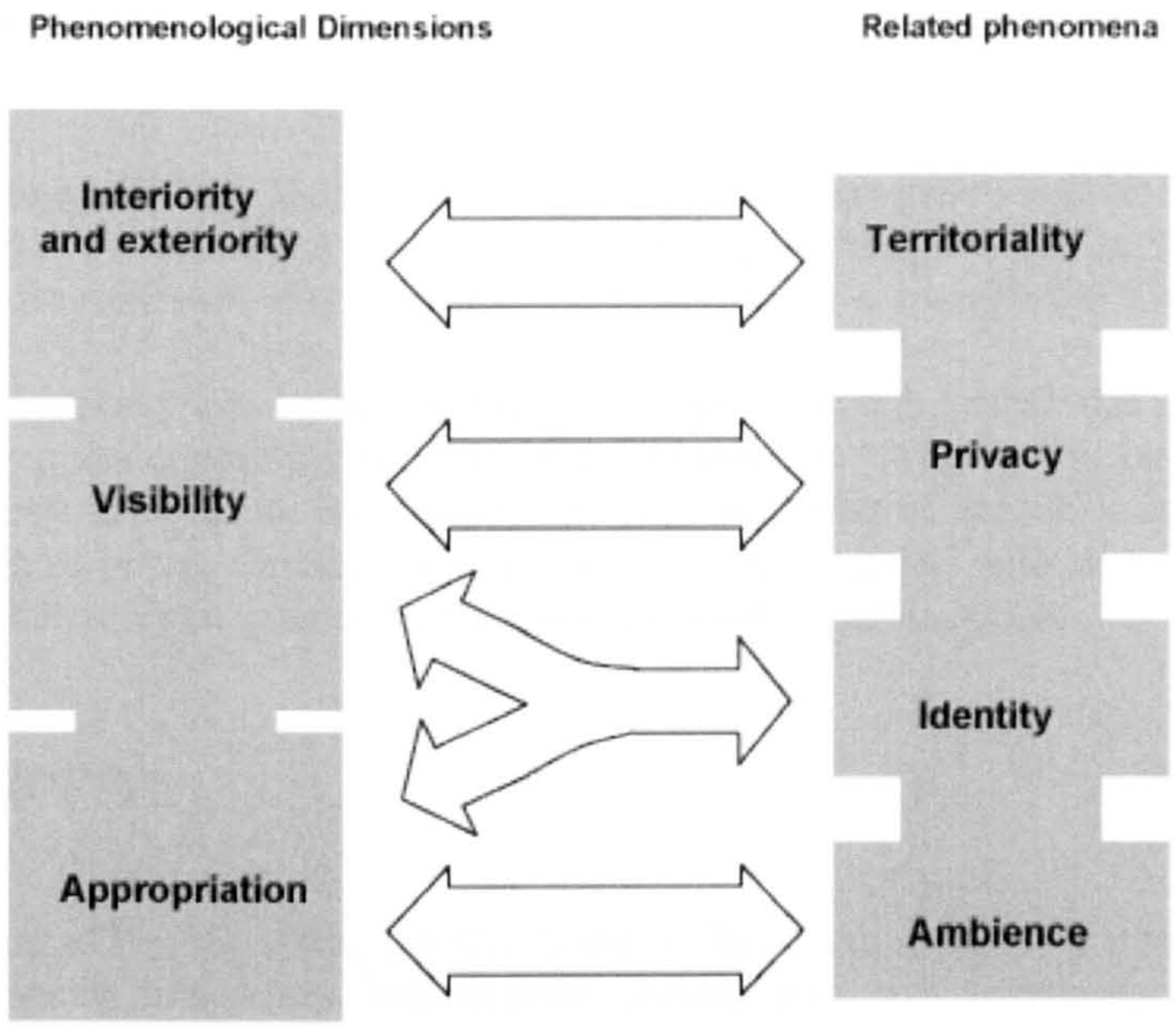

Figure 9: Physical characteristics and related behaviour

Malard details the qualities based on the work of many authors, expanding the approach to the way they originate and develop. A summary of those is as follows:

2.3.2. Territoriality

Territoriality is the process in which an area (aerial, terrestrial or aquatic) is maintained in order to preserve and protect a person or group. The activities that take place therein aimed at protecting an area are termed territorial behaviour. Territorial behaviour, therefore, includes all the devices that use the space with the aim of securing that territory. Thus, this territorial quality is related to human purposes when human beings give a sense of appropriation to the space, generating marks to identify the place boundaries. At the same time, this generates marks delineating the space concerned, thus granting identity: showing to the members of a community, who lives inside that space, and how to recognize their limits.

The social interaction inside a territory is ruled by a dominant group in order to improve the defence of the space. The spatial elements of territoriality permit an easy identification of the violation of boundaries by outsiders, and easy internal communication about any invasive event taking place inside the territory. The sense of owning a territory can be given by some patterns of behaviours, and '*possessing*' an area means knowing how to use the cultural set of communication between the people that live there, including their codes, accents, ways of dressing, in short all the elements we can understand that compound personal behaviour and collective identity.

The invasion of a territory can be either physical or visual, and each is guarded against by a different type of protection. Barriers and physical distances can be used with reference to the former, with visual barriers being used for the latter. The maintenance of territoriality is related to knowledge of the state of the boundaries within, permitting the detection of invasions. Thus, visibility is primarily used in that maintenance.

2.3.3. Privacy

Privacy can be defined as the *selective control* of *access* to a person or a group. It can be described as a process aimed at the control of interpersonal events, permitting or denying the participation in social life. In this way the web of relationships established by the social collective is controlled.

Desirable levels of privacy can be established by means of spatial, verbal and cultural behaviour. Normally, privacy in its commonly used sense is obtained by using spatial elements to separate activities, or even by using time, for example in the scheduling of activities in order to separate them. The patterns of privacy inside a cultural set can be modified with time, and normally the culture makes the behavioural rules to express actions inside a public space.

2.3.4. Identity

It is the conjunction of beliefs, ideas, general qualities that make us sense that we are both unique *and* able to share social life values. Individually, identity promotes differentiation and individual distinction.

Collectively, however, this gives individuals elements that can be recognized as patterns (for instance, accepted behaviours inside the space) to integrate a person into a group. So, identity involves both the individual domain and the public domain. The concern for preserving a place's identity is shown in the efforts made to maintain and reveal the uniqueness of the elements of a place. This involves a previous intentional idea of what to express (the identity), which elements are unique and why, and it expresses consciously the maintenance of its identity. Other mechanisms can be used to express the identity of a place, such as rules affecting people's behaviour.

2.3.5. Ambience

As was mentioned previously, this quality is related to all those facts that turn a place into an enjoyable interior. It reaches into a subjective dimension, in which one can experience emotional responses to a place. To observe this quality we need to interpret how people are willing to maintain a place, how they care to correctly use the equipments located in it, etc. Objective measures of comfort, and others related to maintenance are the kinds of information that are indicative of ambience.

An analysis focusing on the phenomenological characteristics of interior/exterior, visibility and appropriation can make clear how those characteristics could be interpreted as being related to the physical elements and to people's activities. Firstly, however, some of the terms of that analysis should be clarified. To do so, the next section will summarize some initial concepts based on authors who have addressed a concern for place making. As is the case with other situations in this framework, those concepts are to be accounted for briefly, concerning the essential scope in which to develop a theoretical approach towards the architectural use of Information Technology in urban spaces.

2.4. An analysis of the characteristics of place

Alexander (1979) has mentioned that space and activities could be regarded as a unit of analysis in the study of the qualities of places. His concern was to reflect his adopted philosophical paradigm (Alexander, Christopher , Ishikawa *et al.* 1977) through which the view of a subject, regarded as user, would not be considered in isolation from the object, the physical space where that subject performs his/her activities. Through this analysis, Alexander considered the approach towards a holistic spatial analysis could be more concise, avoiding the simplification that normally happens when separating concepts such as *form and function*. Using that same conceptual reference for the purposes of a place-based analysis, the view taken in this framework is that:

1. *An event is a totality composed of human actions and the space it is required to take place in.* An analysis of events will use references to the formal characteristics of spatial elements involved in the activity (shape, colour, characteristics of the material) and references to characteristics associated to the occurrence of the phenomenon (time, frequency, speed, movement, intensity, etc.).

2. *An event is an element of place when its occurrence is persistent.* All the events in a place either compete or cooperate among themselves in order to persist and gain the quality of duration. When they are competing, it is said that there are *conflicts* between them. Nevertheless, events in conflict can be persistent in a place.

3. *Components of the place are a topological reference of persistent arrangements of events* which, by means of their topological structure, contribute to the definition of the phenomena of interiority/exteriority, visibility and appropriation.

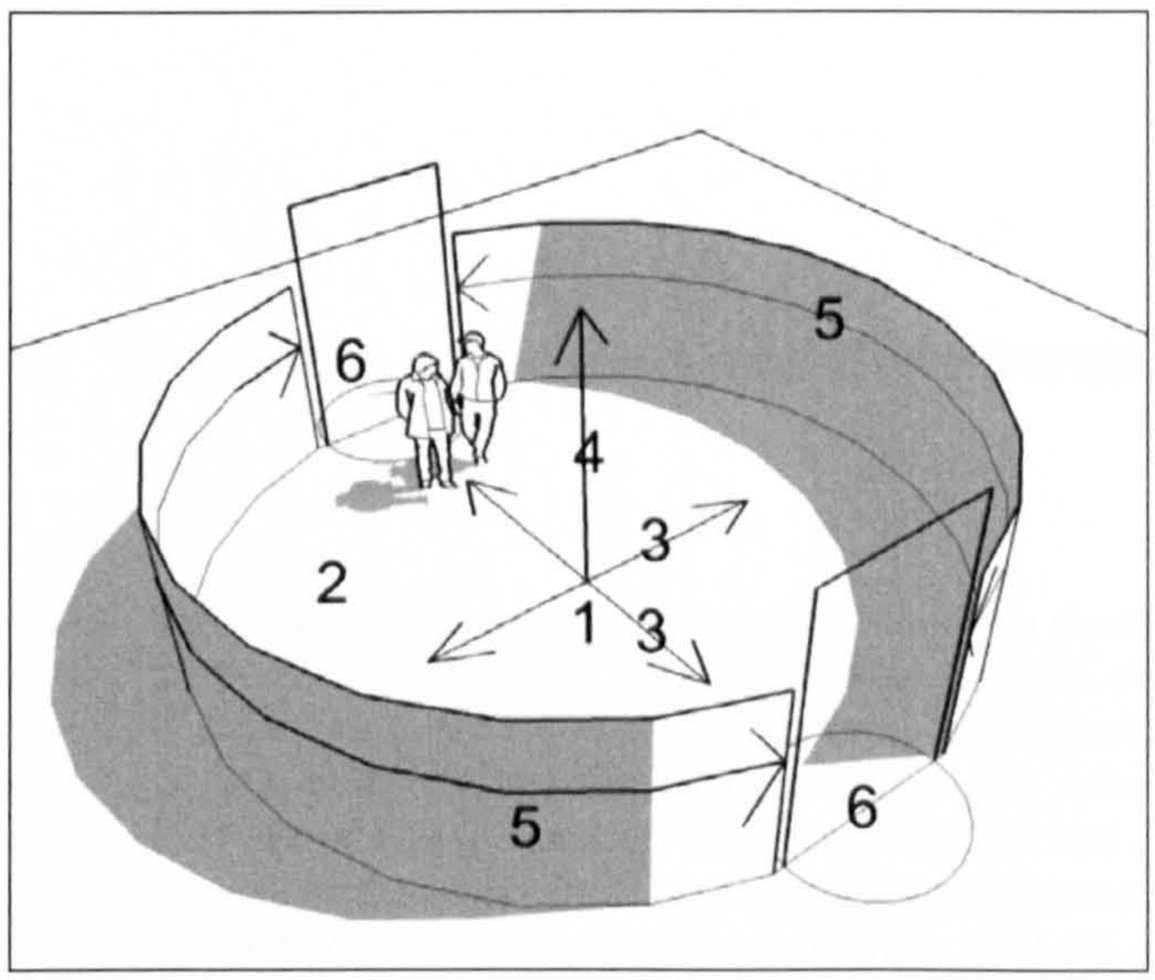

Figure 10: Components of place as persistent arrangements of events. Each number in the figure can represent a phenomenon topologically related to the place's definitions. The topological character of this model permits to analyse a wide variety of situations.

Once the concepts just mentioned are considered, the topological characteristics of the physical components can be related to the qualities of TPIA using the same elements that were defined as the structure of information in the place (see section 1.10, on page 31). It should be noticed that the scale of many events, playing as topological elements of place, can interfere in the interpretation of

this model (see for instance the example given in Figure 5 on page 33). Two places, for instance, despite having the same topology, can differ in terms of their meaning considerably, so this property should be carefully interpreted.

According to Figure 10, an interior is defined by delimitating a chosen internal area (2) from the exterior. This delimitation implies the creation of an enclosure (5) which involves an internal volume. A territory differentiated from the outside space is created in this process. The quality achieved by the process of differentiation is known as *territoriality*.

Once defined as the interior, appropriation by people will generate *centrality* (1), which means a set of organized central points which identify the areas in the territory as markers, and help to organize hierarchies of events supporting the internal movements with easy orientation.

The events that happen inside the internal volume of the place can be meaningfully aligned in the horizontal (3) and vertical directions (4). The peculiarity of this alignment, in terms of visible characteristics confers identity onto the interior. The way people use, maintain and preserve that interior while appropriating it by their activities confers ambience.

The visible form of the enclosure, from the outside, and the peculiarity of its internal surfaces will confer identity on that place; and the means by which the enclosure allows the interior to be visible (or invisible) and accessible from the outside determines privacy.

A controlled connection with the outside is made by an entrance (6), the visual and control aspects of which contribute to identity and privacy. Thus, the components analysed here are:

a. Centrality
b. Internal area
c. Horizontal directions
d. Vertical directions
e. Enclosure
f. Entrances

2.5. Conflicts between spatial elements and activities

As architectural space has been regarded here as '*equipment*' in which to dwell, this implies that its defects affect the qualities of dwelling. Therefore, when we observe which physical elements of a place interact with people's activities to generate those qualities, it is possible to describe those defects in terms of missing spatial elements or their malfunctioning with reference to TPIA. To do so, firstly, it is needed to be aware of which conflicts between activities and space take place, and secondly how to describe thoroughly the interaction between spatial elements and human activities involved in the conflict. This method was extensively mentioned by Malard, and is called here the '*identification of conflicts between spatial elements and activities*'. This method can be summarised as follows:

Detecting a conflict between activities and space.

This detection is possible by means of what Malard calls '*reading space*', which is her interpretation of the Heideggerian breakdown applied to space. As has been seen in Section 2.2.1 on page 38, space can be considered as equipment and its breakdown can reveal essentially how it

is being affected. '*Reading spaces*' takes place when architects observe how the activities and spatial elements in the place are in conflict. That evidence becomes visible when it is possible to detect the absence of an activity from a spatial element. All kinds of data about the conflict must be considered in order to report it: drawings, photos, video footage, questionnaires and interviews with users, etc. Sometimes, it is possible to interpret a conflict only by seeing how the spatial elements are damaged, broken or threadbare. With this technique, it is possible to infer which problems have provoked that state, thereby detecting the conflict.

Interpreting how conflict interferes with the qualities of a place.

This means describing the conflict in terms of the qualities of TPIA, relating to the activities that take place in it. Normally, one conflict interferes across more than one quality. Therefore, it is useful to list the qualities in order to highlight how each quality has been affected by the conflicts described. In order to do so, the use Table 2 is suggested as a reference point for recording the process of reasoning related to interpreting identified conflicts.

Categorization/ name	Conflicts descriptions	Affected qualities				Spatial elements	Documents References
		T	P	I	A		
Name of the conflict: **Spatial element** X **Activity**							

Table 2: Table used to record the analysis of conflicts (See for an example on page 217).

An example of the use of this table can be seen in the report concerning conflicts identified in Fargate Street, the Appendix entitled 'Fargate Project: Conflicts Report' attached on page 217. In that report, the conflicts were described and reference was made to a record compiled from other documents, such as photos, maps, local observations and the like. After a textual description had been made of each conflict, these were summarized in Table 3. That table also contains information about the position and frequency of the conflicts observed, expressed in the following terms:

Legend:
T=Territoriality; P=privacy; I=Identity; A=ambience;
L=Local; G=general;
M=Morning; A=Afternoon; N=Night

Conflict Name	Affected quality				Location		Frequency			Element or condition missing
	T	P	I	A	L	G	M	A	N	
Transient Protection X Lack of canopy in the entrance of shops:	x		x			x	x	x	x	Canopy or other protective element
Transition between territories X Lack of transitional space in the shops	x	x	x			x	x	x		Shop entrance transition spaces.
Clear orientation X Lack of hierarchy in the public open space		x	x	x	x		x	x	x	New design and layout to the street surface

Elevated central point to X Lack of defined central point	x		x	x	x		x	x	x	A central point, a monument, sculptures, or fountains.
Resting in public space X Lack of good benches		x		x	x		x	x		Benches
Shops Supply X Lack of service entrance				x		x	x	x		Urban solution or equivalent
Circulation of cars X Lack of defined path to cars				x		x	x	x	x	Paths for cars
Identity X Lack of uniqueness			x			x	x	x	x	Re-shaping the buildings
Visual signs X Disorder	x		x	x		x	x	x	x	Ordering of visual communication
Private use of urban equipment X Lack of defined territory to urban furniture	x	x	x		x		x	x	x	Re-layout of urban equipment and furniture
Communal Sense in night time X Lack of luminosity	x		x	x		x			x	New Lighting project
Visibility of street precinct X Visual obstacles			x		x		x	x	x	Getting rid of visual obstacles or increasing visibility.

Table 3: Example of use of table 2 in Fargate report

Table 2 permits allows for the scrutiny of the qualities that have been affected in the place and makes it possible for the missing elements that have caused these to be explicitly stated. Once those spatial elements are specified by the architects, another table showing how digital technologies components can be used to invigorate those qualities will be suggested in order to assist them in the creation of systems that incorporate digital technologies components associated with specific solutions to each conflict. Chapter 3 will discuss each IT component in order to build up another table that will relate these to the particular spatiality of the place.

Associating a spatial element that is missing or malfunctioning for each conflict.

Finally, it can happen that more than one conflict originates from the lack of a single spatial element and detecting this requires economy, since the repositioning, recasting of refurbishment of that element can resolve more than one conflict.

Since we have discussed the development of this framework focusing on a theoretical approach regarding place and the means of analysing it, we can now move on to an emphasis on how individual components of IT can be correlated with the aforementioned qualities that were affected by conflicts. This will involve interpreting the digital technologies components on the basis of their potential for deployment in the invigoration of particular qualities. This is what will occupy us in the next chapter.

Chapter 3:
Development of a Framework
Part II: IT in the Place

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Development of a Framework
Part II: IT in the place

As a sequel to Chapter 2, this chapter presents a systematic exposition of the essential spatial attributes shared by all components and processes of a generic Information Technology System when used in public spaces to reinforce their qualities. These spatial attributes will be connected through an analysis of the topology of the place. This analysis will then lead to correlations between IT spatiality and the events in the place, regarded here as structural organizations of the phenomena of communication such as *centrality*, *internal area*, *horizontal and vertical directions*, *enclosures* and *entrances*. The aim of this chapter is to find congruent terminologies and graphical representations to be applicable in the design of IT-supported urban public areas as a means to reinforce the qualities of the place. Thus, the entire hypothesis that has guided the potential usage of IT in urban public spaces is considered in relation to those qualities, previously defined as *territoriality, privacy, identity* and *ambience*.

3.1. Digital technologies components

The components and functions of a generic IT device, classified with regards to spatial attributes, were first clarified by Steve Shafer in his seminal paper "*Ten Dimensions of Ubiquitous Computing*" (Shafer, Steven and Nolan 1999).

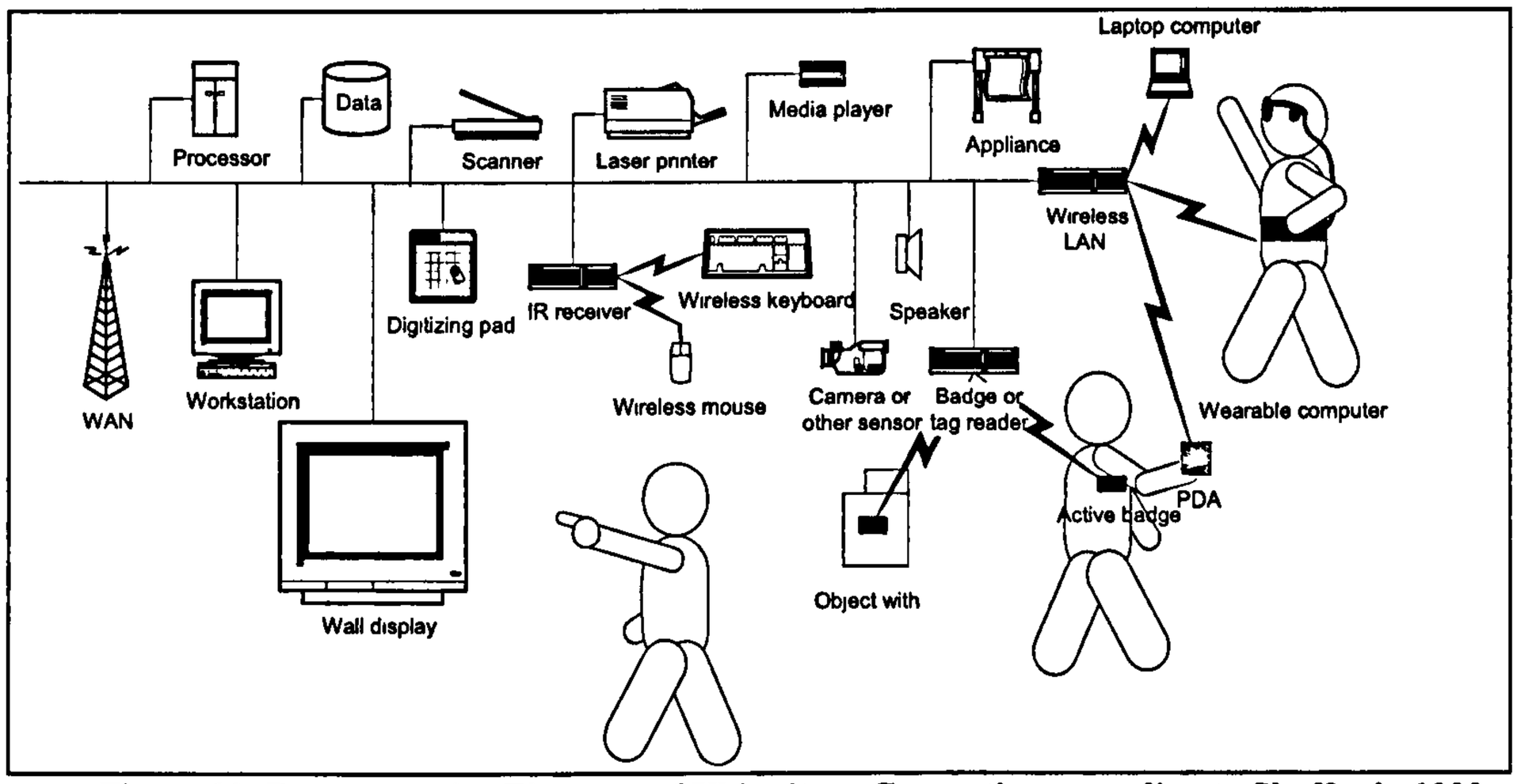

Figure 11: Representative Elements of Ubiquitous Computing according to Shaffer in 1999

McCullough (2004), inspired by Shafer's list (Shafer, Steven and Nolan 1999), enumerated ten essential components and functions from which pervasive computing systems have been composed. His description makes it clear to architects and designers how they could contribute to the field and deal with some principles of IT:

- Microprocessors,
- Sensors,
- Process and devices for tagging,
- Links to communicate,
- Actuators,
- Control process,
- Displays,
- Determination of fixed Locations,
- Software models,
- Tuning process.

On the basis of the classifications of McCullough (2004) and Shafer (1999) in terms of spatial characteristics, it is possible to group the properties of IT devices into four generic categories according to the relationship between the components, of which *'place'* is but one, and their functions:

1) A Group of elements *to sense the place* – Microprocessors, Sensors, Tag, Communication Links;

2) A Group of elements *to modify and actuate the place* – Actuators;

3) A Group of elements that *represent the place* – Fixed Locations, Software Models, Turning;

4) The place itself (called here as the referential matrix to the system).

In order to analyse those components some analytical tables have been done in an attempt to organize information to study the topology of digital technologies components when applied to place. Firstly, the component category is summarized, having been distinguished according to

McCullogh's list. Secondly, a general example of the component is given, with references to its technical features. Lastly, how the component can play as part of the place relative the place's topology is analysed. Thus, the components are analysed in terms of the characteristics they have that interfere across the qualities of the place, in the following table (Table 4):

Territoriality	Privacy	Identity		Ambience
Interiority and exteriority How can generic digital technologies components be related to spatial situations of interior/exterior position of people/elements in the place? This column describes general situations where IT components could affect the quality '***territoriality***'.	**Visibility** How do digital technologies components relate to spatial situations of visibility of people, activities and spatial elements, considering a definition of interior/exterior and helping the quality '***privacy***"? This column describes some general applications related to visibility in what visibility is involved with that quality.	**Visibility** How can the visible appearance of the place be related to IT components? This column tries to describe processes in which the visibility of the place could be transformed into useful information to generate spatial outcomes.	**Appropriation** This column describes how IT components could help to transform the way the users use the place into useful data to understand how they appropriate of the spatial elements. The outcome of using such information is suggested as an application related to '***identity***'.	**Appropriation** This column describes how information gathered in the process of appropriation of the place by the user could be related to IT components. All the actions to take care, maintain and preserve the place (including cleansing, maintenance, adjustments and environmental comfort, etc,) are considered in terms of spatial output to reinforce the quality '***ambience'***.

Table 4: Analysis of IT components according to the qualities of place.

3.2. Components to sense place

Components that sense a place are all the components and processes that sense modifications in the environment in terms of changes in some kind of energy transform it into processed data and transmit it to a connected server. Those components include microprocessors, sensors, tags, and communication links and all the spatial procedures according to which they are organized.

3.2.1. Microprocessors

Probably the simplest definition of microprocessors comes from the *High-tech Dictionary* (Computeruser 2004): '*a computer with its entire CPU(Central Processing Unit) contained on one integrated circuit*'. This means that a Microprocessor is a complete computation engine that is fabricated on a single chip, being programmable or having limited programming facilities, emphasizing self-sufficiency and cost-effectiveness. They are normally described as incorporating the functions of processing programs, storing information and performing calculations. Introduced in 1971, they have nowadays become the most complex mass-produced product ever, with more than 5.5 million transistors performing hundreds of millions of calculations each second.

'*Microcontrollers*' is the name given when a set of components is associated with microprocessors in a single device. Many of these are either not programmable, or have limited programming

facilities, emphasizing both self-sufficiency and cost-effectiveness. The microcontrollers contain all the memory and interfaces needed for a simple application whereas a general purpose microprocessor requires additional chips to provide these functions.

In terms of spatial issues, microprocessors and microcontrollers can be regarded as performing localized and punctual operations, such as gathering, storing, processing and delivering data from a fixed element in the place. Moreover, when they are associated with other electronic components, such as sensors, they add up functionality by tracking changes in the physical environment. When associated with components that permit the transmission of data, an ad hoc web can be created by linking each microcontroller by means of laser or radio frequency. These are known as *Wireless Sensor Networks* (Networks 2007), firstly developed at the University of California, Berkeley. It consists of small microcontrollers (7mm length) that can be distributed over a target area. Each microcontroller connects to the others in a small range of transmission (up to 300 metres outdoors), creating temporary connections towards the server, only when the connection is necessary. Continuous connection and reconfiguration of the ad hoc web are achieved by linking multiple hops and "hopping" from node to node until the destination is reached, thus avoiding broken or blocked paths. Nowadays the challenge is research into the integration of components, as well as the miniaturization and energy management of the device. Wireless Sensor Networks have mainly been used in industry so far (Edstrom 2006), in applications that include the wireless monitoring of temperatures, pressures, and tank levels in oil refineries; the retrofitting of commercial buildings to monitor temperatures and daylight levels in order to save energy; monitoring pollutants in smokestacks; and security applications such as moveable '*wireless fences*' that sense approaching objects . In recent years, the *Smartdust technology* has mainly been used to control industrial processes and environmental monitoring. Others applications are possible, such as, for instance, irrigation management, frost detection and warning, pesticide application, harvest timing, bio-remediation and containment, water quality measurement and control.

By providing intermittent and local communication, microprocessor usage stands in contrast to the well known *anytime-anyplace universality* through which IT is commonly regarded (McCullough 2004). According to those characteristics, it is possible to analyse how they are potentially related to the properties of place in some applications. The following table summarizes their features that are related to the place's topology and gives some examples and references. A comparison of all digital technologies components in a unique table can be found on page 257.

	Territoriality	**Privacy**	**Identity**		**Ambience**
	Interiority and exteriority	**Visibility**	**Visibility**	**Appropriation**	**Appropriation**
Microprocessors process programs, remember information, and perform calculations.	Related to Interiority when they are spatially spread in order to store and deliver information about delimited areas, interiors, fences, limits.	Related to visibility when they offer access to information about position, regarding implementation of data to represent graphically invisible situations that can interfere with privacy, approximating to invasion, absence, invisible invasion, etc.	Microprocessors embedded in elements of the place can store information about those elements. Would be more efficiently recognized by visual magnification or textual reference, potentially interfering with local identity.	Microprocessors could gather, process, and offer information about how some physical elements have been set up (moved, changed, appropriated, etc), enabling knowledge about how people use them to appropriate of the elements of place.	Microprocessors could gather information about user preferences, recording and calculating which situations have occurred, feeding others devices with information that help to customise the Ubicomp system.
	Example: In the '*In-Building Navigation Project*', microprocessors are	Example: Many applications can be designed, such as those similar to the	Example: '*The Laboratory for Intelligent Structural*	Example: The applications displayed at '*The Laboratory for*	Example: Microprocessors integrated in systems can cope

	used to help mapping building interior to inform the user where to go. (Huy Nguyen 2007) See http://www.cs.washington.edu/education/courses/cse477/projectwebs99au/groupi/	'*Cricket Indoor Location System*', so as to sense the movement of target points using fixed microprocessors. The moving points become visible, showing potential invasion or intrusion into each territory. See http://oxygen.csail.mit.edu/index.html.	*Technology* '(*LIST*) at the University of Michigan has developed many applications in which microprocessors and sensors are embedded in walls, structures and even inside the human body to monitor their conditions. Such technology could be easily translated to place elements. In some cases, the microprocessor could contain information about the element in which it is embedded to help visual identification, recognition and so on. See http://www.wimserc.org/	*Intelligent Structural Technology* '(*LIST* and the related Centre of Microsystems at http://www.wimserc.org/) are helpful to suggest that microprocessors can grab information about user modifications in the environment or set up of new arrangements of functions inside a place.	with monitoring the interior conditions of rooms and gathering data about the preferences of users. See http://oxygen.csail.mit.edu/index.html

Table 5: Analysis and examples of spatiality of microprocessors.

3.2.2. Sensors

Sensors are electronic devices used to detect and measure physical quantities such as temperatures, pressures and convert them into an electronic signal of some kind. When wirelessly connected to a web, the resultant network can be useful to many applications, monitoring, alerting and controlling scenarios in which minute measurements over a range of analytical sensor inputs are delivered.

One example of sensors gadget and application is the sound sensors, that were developed to solve the problem of keeping audio levels of a place consistent during times of fluctuating background noise. The example provided at http://www.museumtools.com/sensors.html was designed to automatically adjust the volume of other sound source as tape player, CD, digital repeater, computer or other sound source, as the background noise rises and falls. When paired with sound speakers, the sound sensors deliver audible, focused sound whether the space is quiet, or filled with loud background noise.

Other example is the *Location Verification Systems* project (http://www.cs.berkeley.edu/~nks/locprove/), developed through the system *TinyOS* (http://www.tinyos.net/ and http://webs.cs.berkeley.edu/tos/). It is a specific operational system designed for use with embedded networked sensors enabling location-based access control. Once a principal location has been verified using a protocol for location verification, it can be granted access to a particular resource according to the desired policy. This approach is combined with physical security; guards or locks might be used to determine who is allowed to enter a building, then location verification is employed to allow wireless access to all those inside. Therefore, the location verification problem is the key technical challenge that must be surmounted in order to implement location-based access control.

Other example of sensors usage on the wall is the Integrated *Quantitative Monitoring of Structural Integrity* (*IQMSI*), which uses dust technologies to monitor structural damage after earthquakes.

The system is made up of tiny self-contained sensors, which are installed near critical structural points in a key building. Onboard intelligence discerns normal structural deterioration and significant damage. Sensors report the location and kinematics of damage during/after an earthquake, allowing rapid, accurate structural health determination. To do so, the research has developed the *Echo protocol* which permits a set of verifiers to verify whether a microprocessor is near in a region.

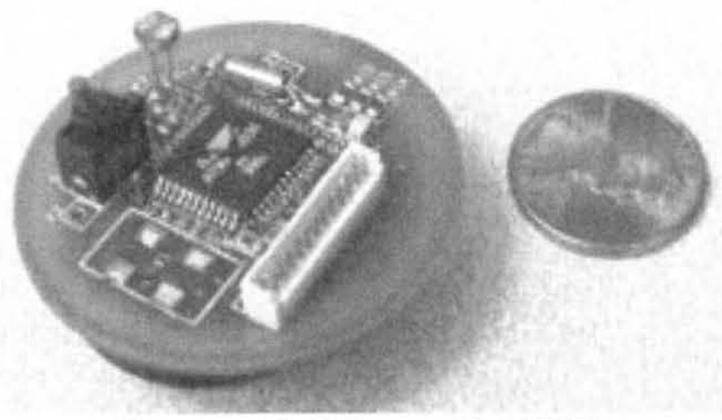

Figure 12: Mote of IQMSI

Using radio signal information alone, the project *MoteTrack* (http://www.eecs.harvard.edu/~konrad/projects/motetrack/) researches into the use of sensors to determine the location of a roaming node at close to meter-level accuracy. They are particularly concerned with applications in which the robustness of the location-tracking infrastructure is at stake. For example, fire-fighters and rescuers entering a building can use a heads-up display to keep track of their location and monitor safe exit routes. Likewise, an incident commander could track the location of multiple rescuers in the building from the command post.

The *Environmental Sensors and Subsystems* (ESS) at http://www.wimserc.org/thrusts/environmental.php continues to develop novel sensors, actuators, and micro-instrumentation for a broad range of physical parameters and chemical types. These devices and multi-device ensembles serve as the information-gathering modules of wireless micro-systems whose small size, accuracy, and low-power dissipation will enable them to be widely disseminated in applications ranging from homeland security, environmental quality monitoring, industrial process control, and global climate studies, to biomarker monitoring and medical surveillance. Devices being developed include sensors for organic vapours, reactive inorganic gases, dissolved metals, bio-molecules, ionizing radiation, pressure, temperature, humidity, acceleration, and position; micro-valves and micro-pumps for sample capture and transport; and micro-machined structures for particulate filtration, diffusive vapour generation, pre-concentration, focusing, separation, heating, and cooling.

	Territoriality	**Privacy**	**Identity**		**Ambience**
	Interiority and exteriority	**Visibility**	**Visibility**	**Appropriation**	**Appropriation**
Sensors detect action, measure physical quantities such as temperature, pressure or loudness and convert it into an electronic signal of some kind.	Related to interiority, for instance, when they are able to sense whether a moveable element is inside or outside a pre-established territorial delimitations. Controlling the sound in the interior can demark the internal area.	Sensors are related to privacy by sensing proximity, invasion, thus permitting surveillance, and informing when an action is needed to react against invasion. Sensors can sense internal noise and inform a processor to deliver inverted waves through speakers, in	Sensors could permit Identification of visible users according their tag. They could also Permit users to identify specific elements according to specific concerns.	By the use of 'gesture sensing' technology, they could Sense mechanical movements, adjustments in order to tune the system, distinguishing how the user appropriates the place.	These could integrate systems in order to sense changes in temperature, pressure, light, sound, when the user tunes the system, allowing information about how the user appropriates the place to be gathered. These would permit the creation of collections of info about those.

		order to grant internal privacy.			variables in order to trigger actions.
	Example: See Cricket Indoor Project at http://nms.lcs.mit.edu/projects/cricket/	Example: This feature is extensively examined in the *In-Building Navigation Project,* http://www.cs.washington.edu/education/courses/cse477/projectwebs99au/groupi/. Other numbers of sensors indistinctly sense approximation and are commonly used in lifts, automatic doors and other devices.	Example: Once a user has a tag, a specific sensor to that tag can inform of his presence and exchange information, making the place '*more visible*'. It could support systems that deliver tourist information according to the interests of the users, identifying the users preferences.	Example: Projects like the '*Easy Living Project*' (http://research.microsoft.com/easyliving/) look at all sorts of records of users' activities in order to facilitate interaction with controlled switches in an intelligent room.	Example: Associated with software configuration, users' records about the appropriation of of elements of place could facilitate interface contact, as it can be seen in the themes developed in the *Microsoft Socio-Digital Systems Group* at Cambridge (*http://research.microsoft.com/sds/*).

Table 6: Analysis and examples of spatiality of sensors.

More information on research into sensors can be found in *The Sensors and Devices Group at Microsoft Research Cambridge* web page, UK, at http://research.microsoft.com/sendev/ . A comparison of all digital technologies components in a unique table can be found on page 257 of this thesis.

3.2.3. Tags

A tag is a relevant keyword or term associated with or assigned to a piece of information (like picture, article, or video clip), thus describing the item and enabling a keyword-based classification of the information it is applied to. Tags are usually chosen informally, not usually as part of some formally defined classification scheme. They are typically used in dynamic, flexible, automatically generated taxonomies for online resources such as computer files, web pages, digital images, and internet bookmarks.

In terms of IT, a tag can be an electronic identifier through which delivered information can be rapidly grasped, facilitating interaction with humans or activities. A tag has the ability to inform standard packages of the information required as identification or surveillance. A radiofrequency identification tag costs less than a dollar in 2001 and it is expected to get cheaper in the future. Tags are popular in the barcoding of products and more recently for identifying more accurately the characteristics of each product by using electronic product codes, which are tags designed to replace barcodes. Smart touch-sensitive counters, such those used on bins in parts warehouses can conveniently monitor the flow of goods without reference to all the usual point-of-sale documentation. Any place in which large numbers of such tags are read, particularly the point of sale, in effect becomes an important component in the use of space. When the tag utilizes any form of language or computational skill, the tagging process is able to bring software into the physical environment. They can be associated with wearable pieces such as badges, and could be used for personal identification in the form of ID cards with magnetic stripes, containing interactive data permitting modification by a central server and other useful information in biometric form. The following table summarizes the spatiality of Tags. A comparison of all digital technologies components in a unique table can be found on page 257.

	Territoriality	Privacy	Identity		Ambience
	Interiority and exteriority	**Visibility**	**Visibility**	**Appropriation**	**Appropriation**
Tags identify actors.	Tags identify actors inside and outside. These detect territorial invasions and give information about how to behave, which territorial codes should be observed and about territorial limits.	Tags can determine what can be seen, telling what to hide or to show when representing graphically information about elements of place.	Tags can help in the selection of specific types of information about what is being seen, so the local identity can be depicted according to user concerns.	Tags could select information about specific modifications occurring in the appropriation, such as info about the usage of physical elements	Tags could provide useful information to users with special needs, such as disabled people, about access, secure paths, age restrictions on users, etc.
	Example: A tagging situation can be seen in the surveillance process using electronic tags to sense the position, as is depicted at http://www.xtagltd.co.uk/xtag_faqs.html and http://indoorlbs.com/id232.html	Example: Cards, tickets, bars codes, e-tags and others can select which resources will be available to a service, as in many commercial situations. (see an example of i-button at http://www.joelee.co.uk/2001/kimm/useibox.html)	Example: The User-Oriented *Pedestrian Navigation Service (utopian),* developed by the University of Münster, is a location based service for recreation facilities and gastronomy offers combined with a navigation service for pedestrians. Because of tags, shops and services become visible. http://utopian-online.de/	Example: Tags can specify which users would have access to specific services and spaces in the place. This can be considered as a resource (energy, water, etc) saving measure in many situations when these are not needed for all the users.	Example: *RFT (Radio Frequency Transmitters*) are already used to assist disabled people in some services in UK. The tag, in this case, is the device for receiving the related information. (some similar mechanism can be seen at http://www.apogeeindustries.com/RFID.htm)

Table 7: Analysis and examples of spatiality of tags.

3.2.4. Communication links

Devices need to establish connections when they have specific demands. They need to know whether, in the proximity, there will be any link to transmit information or to require a service. Such communication links capability and some level of intelligence for signal processing and networking of the data are normally wireless. Some examples that can use ad hoc links follow:

- Military sensor networks to detect and gain as much information as possible about enemy movements, explosions, and other phenomena of interest.
- Sensor networks to detect and characterize *Chemical, Biological, Radiological, Nuclear, and Explosive* (*CBRNE*) attacks and material.
- Sensor networks to detect and monitor environmental changes in plains, forests, oceans, etc.
- Wireless traffic sensor networks to monitor vehicle traffic on highways or in congested parts of a city.
- Wireless surveillance sensor networks for providing security in shopping malls, parking garages, and other facilities.
- Wireless parking lot sensor networks to determine which spots are occupied and which are free.

Recently, the NTT company has developed *RedTacton technology*, which is a new Human Area Networking technology that uses the surface of the human body as a safe, high speed network transmission path. The movements of users constitute the sequence of transmitted information, covering the last small scale of webs and permitting the integration of it by means of local and internet communication. Further details at http://www.redtacton.com/en/info/index.html .

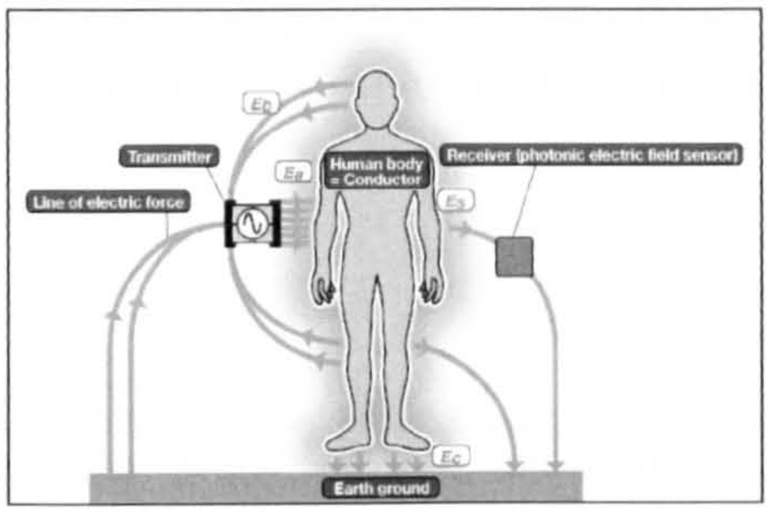

Figure 13: Redtacton technology: http://www.redtacton.com/en/info/index.html

The following table presents some examples of spatiality of communication links regarding the events in the place. A comparison of all digital technologies components in a unique table can be found on page 257.

	Territoriality	Privacy	Identity		Ambience
	Interiority and exteriority	**Visibility**	**Visibility**	**Appropriation**	**Appropriation**
Communication Links can form ad hoc network of devices.	A set of elements from a place could be established in the form of links so as to act as delimiters, defining interiors.	Physical elements that grant visibility can be networked and can trigger actions to block or control privacy.	Physical elements can retain a certain level of flexibility in terms of location, inside a visual field defined by the linkage among them.	Former configurations of physical elements can be detected. New configurations can be memorized and stored.	Linkage established can reveal users appropriation and preferences.
	Example: Some resources provided by *Crossbow Hardware* Platform permits intermittent and ad hoc linking to create a web between devices. See http://www.xbow.com/Products/productdetails.aspx?sid=245	Example: At http://www.xbow.com/Products/productdetails.aspx?sid=245 it is possible to see examples on Environmental/Agricultural Monitoring and Analysis.	Example: In some instances, a set of linked devices can make the visibility of a node inside the boundaries created by the links visible and 'tangible'.	Example: In projects such as the '*easy living*' (http://research.microsoft.com/easyliving/) furniture and user habits can be memorized as clusters linked together within the interior.	Example: A sequence of devices used in a room can, by linking ad hoc, communicate the user's behaviour. Easy living project mention such strategy. (http://research.microsoft.com/easyliving/)

Table 8: Analysis and examples of spatiality of communication links.

3.3. Components to modify the place

These are a group of elements that modify or actuate a place: components and processes that work by causing modifications, influencing the environment physically by delivering some types of energy. These are named *actuators, process of control and all sorts of displays*;

3.3.1. Actuators

The idea of actuators is probably most popular among architects who have have included the use of robots and programmed mechanisms in their projects. An actuator is the mechanism by which an agent acts upon an environment. The agent can be either an artificially intelligent agent or any other autonomous being (human, other animal, etc). All sorts of technologies are involved in the design of actuators (a good journal about is at http://www.instrumentationews.com/daily_news/actuator_devices).

In architecture, one example of an actuator is the *Burke Brise Soleil*, at The *Milwaukee Art Museum*, EUA, by the Architect Santiago Calatrava. It is a moveable, wing-like sun screen that rests on top of the Museum's vaulted, glass-enclosed reception hall. The Brise Soleil, unprecedented in American architecture, is controlled so as to react in the best way to weather conditions by opening or closing.

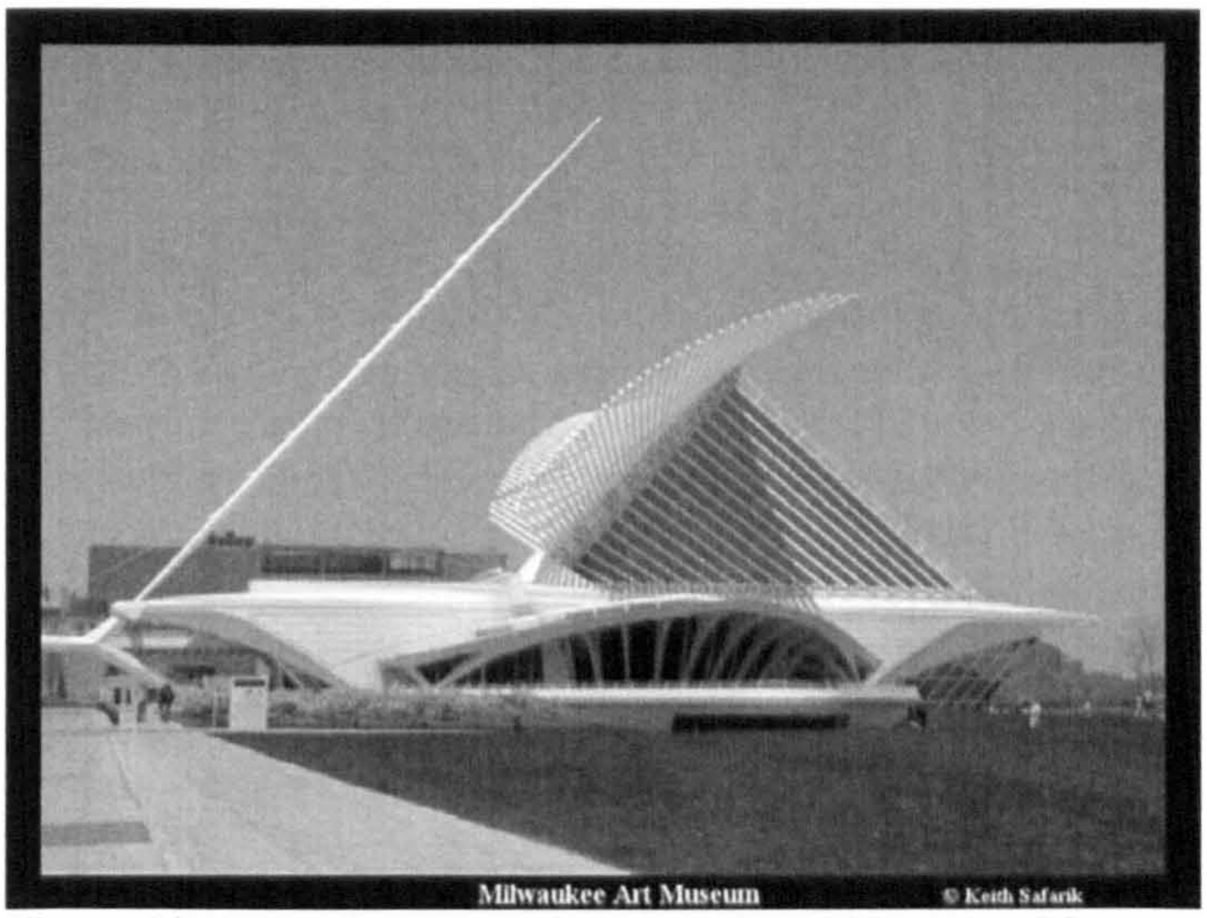

Figure 14: Actuator as part of the building: Milwaukee Museum

Small actuators can only be a *micro-robot*. The ability of a sensor node to move itself or to otherwise influence its location will be critical in sensor networks. The possibility of combining computation, sensing, communication and actuation to not only passively monitor the environment (like static sensor networks) but also actively track, and in some cases mitigate problems is considered a very useful design tool. The *augmenting static sensor networks* with a few mobile nodes immensely benefits the functionality of the sensor network and helps solve many of the design problems of static sensor networks.

The following table summarizes how actuators can be spatially related to the qualities of place. A comparison of all digital technologies components in a unique table can be found on page 257.

	Territoriality	Privacy	Identity		Ambience
	Interiority and exteriority	**Visibility**	**Visibility**	**Appropriation**	**Appropriation**
Actuators alter a system's state when it is triggered by appropriate conditions. They translate electronic signals into physical actions.	Actuators can affect the territory by opening or closing elements of enclosure, adjusting it according to specific local requirements (movable walls, ceilings and canopies, floors, internal directions, fences, delimiters, all in form of servomechanisms)	Openness and visual barriers can be controlled by servomechanisms.	Elements of place can be positioned for better visibility by the use of actuators. Visual identifiers can inform about local identity according to the schedule of activities in the place.	Actuator can provide adjustments of physical elements according to conditions demanded by user habitation, their weight, physical efforts required, movements, etc.	Actuators can be used in self cleaning technologies, auto-adjusting comfort conditions, such as '*brises-soleil*', wind-breaks, sound barriers, etc.
	Example: Simple automatic doors connected to sensors; automatic bollards controlled by software.	Example: Liquid crystal glassing can act as actuators integrated into an IT system. http://www.glassonweb.com/glassmanual/topics/index/crystal.htm The Building *L'Institut du Monde Arabe* by Jean Nouvel is also a notable example.	Example: Building *L'Institut du Monde Arabe* by Jean Nouvel.	Example: The site http://brl.ee.washington.edu/Research_Active/Haptics/Haptics_Index.html provides many devices to regulate conditions to do with user interaction.	Example: The *L'Institut du Monde Arabe* can be regarded as appropriation since the façade suits the lighting requirements of the interior.

Table 9: Analysis and examples of spatiality of servomechanisms.

In the building *L'Institut du Monde Arabe* by Jean Nouvel, the huge south-facing garden courtyard wall has been described as a 60m *'Venetian blind'*, although its appearance is more patently Islamic in decorative terms. It is, however, an ocular device of striking originality, made up of numerous and variously dimensioned metallic diaphragms set in pierced metal borders. These diaphragms operate like a camera lens to control the sun's penetration into the interior of the building. The changes to the irises are dramatically revealed internally, while externally a subtle density pattern can be observed. Thus the whole effect is like a giant Islamic pierced screen, giving significance and an audacious brilliance to this remarkable building.

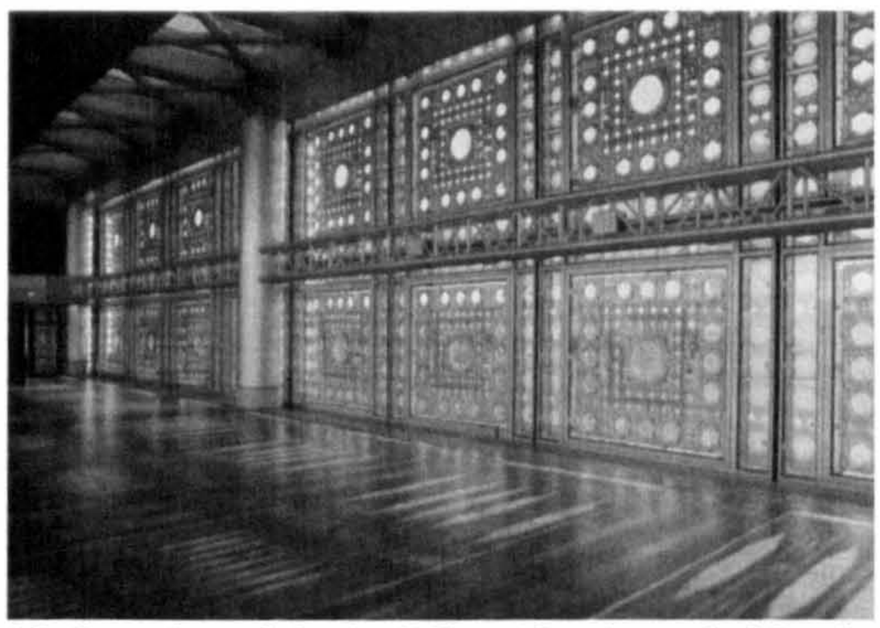

**Figure 15: Interior of the building '*Institute de Monde Arabe*'.
Visibility and ambience controlled.**

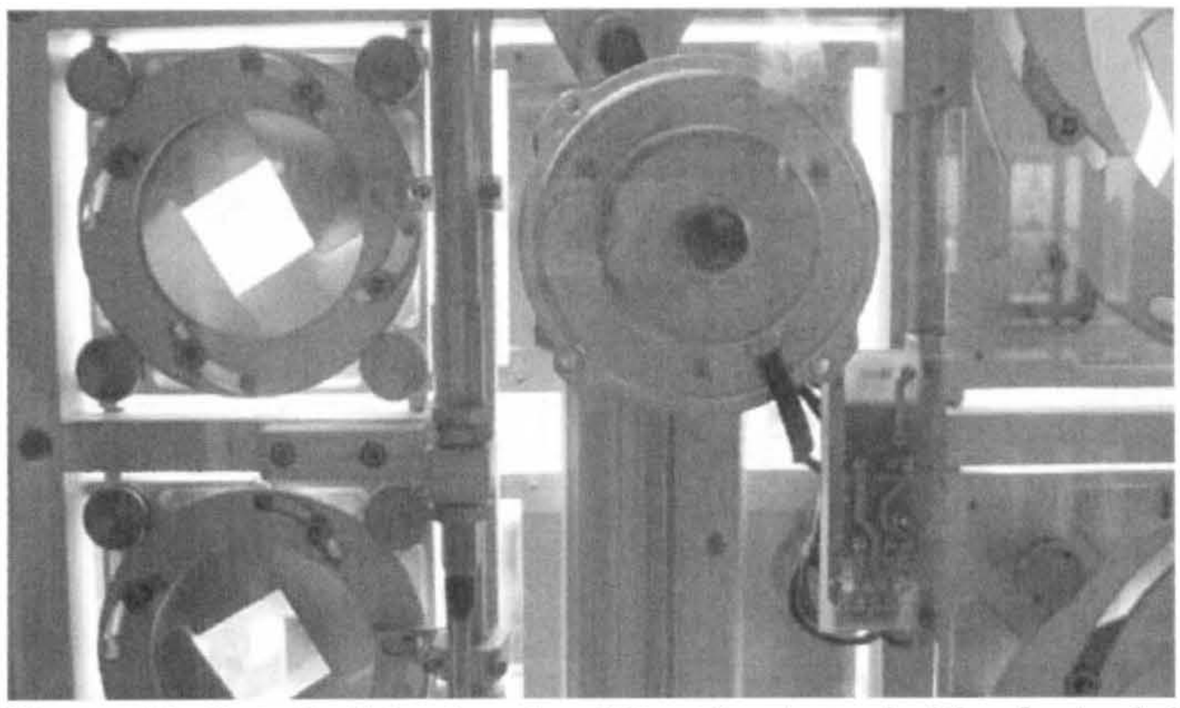

Figure 16: Detail of the facade of the '*Institute de Monde Arabe*' showing a controller to the system.

3.3.2. Process of controls

According to McCullough(2004), '*controls make it participatory*'. Smart systems need to be operable where appropriate, otherwise, simply by being automatic, they become frighteningly overwhelming. Adjustments can be gradual or may be needed to be made constantly. McCullough mentions that the process of controls has to do with the best way of making the control of the devices more interactive with our bodily gestures, avoiding excessive expressions for entry by, for instance, buttons. He compares some good process of control to a musical instrument that facilitates personal growth through skilled practice. Some controls can be based in the body gesture of the users. The Haptic Interface is the practice of communicating, or interfacing, with a computer by means of a tactile method involving a device that senses bodily movement, such as a data glove. Such devices convey a kinesthetic sense of presence to the operator. The key characteristic that distinguishes a haptic interface from passive devices is a bi-directional flow of information. Haptic interface strategies based on gestures, gliders and motion sensing can provide alternatives to the push-button excesses that nowadays pervade the electronic devices industry (an example of this can be seen in http://brl.ee.washington.edu/Research_Active/Haptics/Haptics_Index.html). The following table summarizes some potential spatial relation of Controls with the qualities of the place. A full comparison in a unique table can be found on page 257, regarding all digital technologies components.

	Territoriality	**Privacy**	**Identity**		**Ambience**
	Interiority and exteriority	**Visibility**	**Visibility**	**Appropriation**	**Appropriation**
Controls make it participatory.	Controls need to be easy to manipulate inside the territory, with distinctive identification, resulting in easy recognition of the group that belongs to the interior. The gestures and movements they make could be regarded as a form of territorial behaviour.	Position and state of the controls can be designed in order to avoid revealing internal preferences to the outside world.	Control Positions need to be discrete so as not to interfere with the visible elements	Position and accessibility needs to be "readable" as universal adoption. Preferences about states previously set by users can be recorded.	Controls position needed to permit simultaneous human contact regulation through vision of elements controlled (windows, doors, bridges, fences). Optional states of control, instead of 'on' and 'off' only.

	Example: Systems of control for car parking can be connected interactively with information about available places.	Example: The operation of a control suggests some recognized body poses and gestures, revealing the operations.	Example: The appearance of buttons and handles can interfere with identity.	Example: Too many buttons and switches transformed the household videocassette recorder in a standard emblem of incomprehensibility .	Example: Controls that do not give feedback are uncomfortable and cause distress when it comes to ascertaining which levels were achieved, for instance, in dimming the heating or controlling sound.

Table 10: Analysis and examples of spatiality of process of control.

3.3.3. Displays

A *display device*, also known as an *information display* is a device for the visual or tactile presentation of images (including text) acquired, stored, or transmitted in various forms. While most common displays are designed to present information dynamically in a visual medium, tactile displays, usually intended for the blind or visually impaired, use mechanical parts to dynamically update a tactile image (usually of text) so that the image may be felt by the fingers. Some displays can show only digits or alphanumeric characters. They are called segment displays, because they are composed of several segments that switch on and off to give appearance of a desired glyph. The segments are usually single LEDs or liquid crystals. They are mostly used in digital watches and pocket calculators.

Lately it has become possible to move text and image between many scales and surfaces by projecting. Interaction with visual elements is also possible in some technologies, as in *Arcstream AV* (http://www.arcstreamav.com/). It is a company dedicated to the design and production of large scale spectacular displays for the events and entertainments industries. Giant video projections, water screens up to 20 metres high, lighting and lasers, dancing fountains, computerised pyrotechnics and other dramatic special effects are used to create visual displays that integrate the enclosures (walls, floors, and ceiling) of the place.

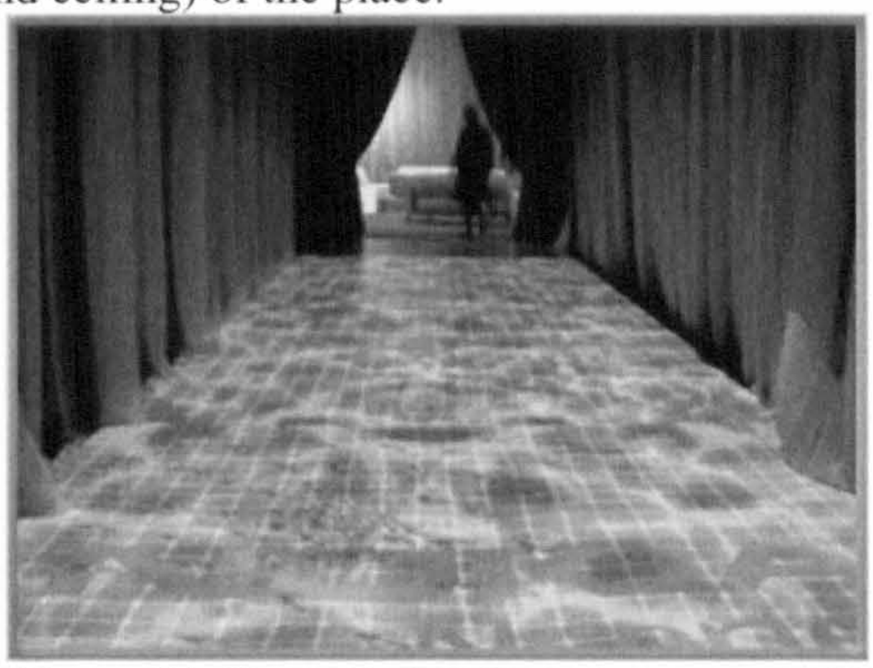

Figure 17: Floor-display from Arcstream AV

Displays can be complementary to many systems of IT when place-integrated. The *Oxygen IBM project* has developed handheld devices, called *H21s*, to provide flexibility in a lightweight design. They are anonymous devices that do not carry a large amount of permanent local state. Instead, they configure themselves through software to be used in a wide range of environments for a wide variety of purposes. For example, when a user picks up an anonymous H21, the H21 will customize itself to the user's preferred configuration. A prototype H21 (see Figure 18) for Project Oxygen

(http://oxygen.csail.mit.edu/H21.html)is based on a *handheld Compaq iPaq* with a 200Mhz *StrongArm processor*, extended by a *custom BackPAQ sleeve* developed with the aid of Project Oxygen and its partners. The *BackPAQ* contains a digital CMOS camera, an accelerometer, a FPGA, an audio codec and headset jack, and two PCMCIA slots (for wireless connectivity and disk storage).

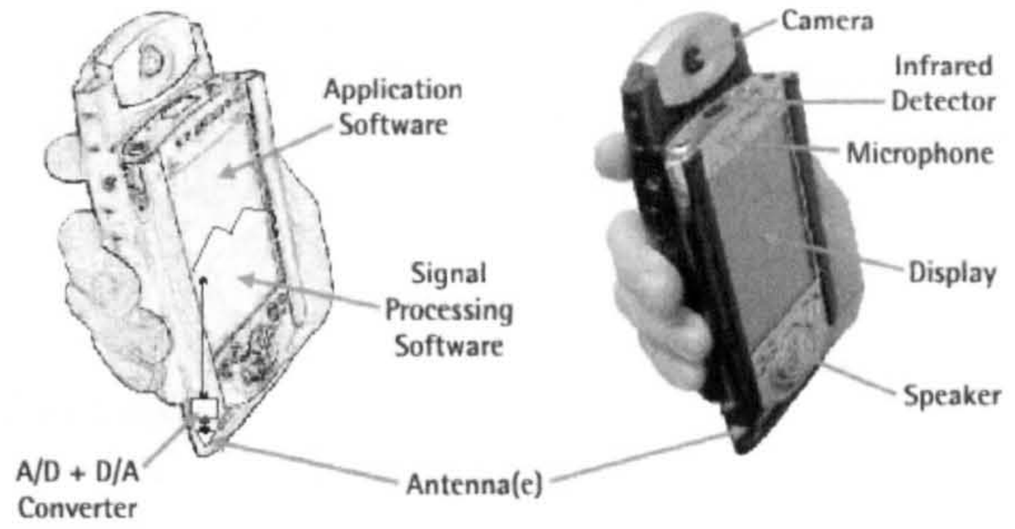

Figure 18: H21 interface

Probably the different sizes of displays above mentioned are good examples to observe the importance of the scale in the role played by the components of digital technologies. It makes clear the importance of considering the relation between the scale of the elements of the place and the components of digital technologies as to find an appropriate solution.

The following table summarizes some applications of Displays concerning the qualities of the place. A comparison in a unique general table can be found on page 257.

	Territoriality	Privacy	Identity		Ambience
	Interiority and exteriority	**Visibility**	**Visibility**	**Appropriation**	**Appropriation**
Displays spreads out.	Displays in headsets can provide readable info in the territories. Confrontation of displayed information with territorial bypassed view can inform about uses, codes and limits.	Cristal liquid displays can control opacity; control of the number of angles displayed from an interior. Visual information about interiors can be brought outside.	Displays can depict information about history, physical characteristics, functional details, warnings, etc.	Displays can improve the understanding of physical changes of elements by showing degradation according to time, uses, etc.	Displays can create an interface for the control of elements involved in environmental comfort, accessibility, etc.
	Example: A small glass can be seen at http://www.microemissive.com/, which permits the aforementioned superimposition.	Example: Headsets used exclusively by one user, creating a kind of privacy.	Example: Headsets and screens can be used as to make visible structures which would be impossible to see without them.	Example: Intelligent scan can provide identification of recognizable patterns in the display.	Example: Displays with touch sensitive screens can parallel other devices in order to provide greater interactiveness.

Table 11: Analysis and examples of spatiality of displays.

3.4. Components to represent the place

These components are a group of elements that represent place: a conjunction of components and processes which permit the adjustment of the whole system by representing data, simulating and predicting patterns of modifications in the environment. This includes techniques related to the determination of *fixed locations, designing and using software models* and all the *tuning processes* of the system.

3.4.1. Fixed Locations

This refers to fixed points that serve to track mobile positions. The technology associated with this resource is called by McCullough "*positioning technology*". The fixed positions, when 'geocoded' i.e. when represented as a key to a record in a relational database, can be delivered intelligently through geographic information systems (*GIS*). *GIS* is normally misunderstood as being only the software used to automate the drawing of maps, but it can enable the production of spatial representations as responses to space-analytical queries, delivering thematic information about the fixed points represented. When used with mobile communication, that information can be delivered when needed. Global positioning systems (GPS) use positioning data to query huge spatial databases that report relevant information back to the position being described. That information can be highly thematic in a *mobile GPS-GIS system*, allowing vegetation patterns, ethnic neighbourhood boundaries, leisure services, and so on, to be studied.

The positioning technology can be associated with tagging, and can help track objects and people that move around. Like products in a retail supply chain, elements of other networked distributions become documented and their flows can be better modelled. Scientific and recreational visualizations of thematic information, *GPS* locator mobile phones and other devices, intelligent transportation systems (*ITS*), automobile navigation system are other possible services that positioning technology makes possible. By 2001, the so-called '*geographic mark-up language*' was introduced into the field, enabling geographical features to be expressed and permitting the interchanges for geographic transactions on the Internet to be made. This language enabled a connection to be made between the real physical world and the representation of the data it provides by fixed locations. The following is a summary of the spatiality to fixed locations correlated with the qualities of place and some examples. A comparison of all digital technologies components in a unique general table can be found on page 257.

	Territoriality	**Privacy**	**Identity**		**Ambience**
	Interiority and exteriority	**Visibility**	**Visibility**	**Appropriation**	**Appropriation**
Fixed locations track mobile positions.	Limits can be defined concerning the '*tracking position method*', permitting identification of location of the interior and purpose.	Mobile positions can be tracked and observed from outside, thus detecting invasions.	A sequence of fixed points can be coded as part of the specific context for a particular meaning in local identity.	Users can be tracked regarding their use of big areas or paths which are related to traditional local activities.	Detecting mobile points related to the movement of users can reveal fluxes that could overwhelm paths or roads, for instance.
	Example: Solutions developed by the company Wherify at http://www.wherifywireless.come exemplify the principles abovementioned.				

Table 12: Analysis and examples of spatiality of fixed locations

3.4.2. Software models

Software models refer to the need to represent scenes and situations related to the place and relevant information thus making various information appliances, smart spaces, and interactive environmental controls possible. In the main, those models are aimed at predicting and prescribing the instances they represent, enabling people to participate in the shared representation of action. They are related to a fertile field of research concerned with knowledge representation, which has moved in the last few years from a preoccupation with artificial intelligence to ontology, that is, the study of the ways of representing the existence of people, actors and things in their contexts. The development of software models of the place is connected with the integrated development of the *geodata* industry, sensor-actuator systems and positioning technology. Next table summarizes the spatiality of software modelling related to place. A comparison in a unique general table can be found on page 257.

	Territoriality	**Privacy**	**Identity**		**Ambience**
	Interiority and exteriority	**Visibility**	**Visibility**	**Appropriation**	**Appropriation**
Software models situations.	Software can represent correct position to tagged objects or persons.	Three dimensional representations of physical positions can simulate closed relations, as in 3d virtual chatroons.	Software can represent physical contexts by the scrutiny of characteristics and properties.	Software can represent the temporally defined appropriation.	Software can represent data about the adjustments made to devices by people to achieve greater ambience.
	Example: Electronic tags and respective software such as those developed by wallmartstores.com.	Example: Second life software at http://secondlife.com/	Example: The software used to programme the façade of the museum Kunsthaus, Graz, Austria.	Example: Receiving input about the number of users, software can determine whether other resources would be needed.	Example: Software can store preferences in terms of user sets.

Table 13: Analysis and examples of spatiality of Software location models.

3.4.3. Tuning

According to McCullough (2004), much of the place-centred character of situated interaction design comes from the fact that any fixed collection of devices has to be integrated. Tuning is a matter of regulating the transfers between component devices to achieve an overall system performance that is not easily predicted by quantitative methods. It consists of incremental adaptations of configurations and settings of all the implied digital technologies components based on qualitative top level interpretation of their performance. Tuning is remarkably closely linked to the identity of a place. According to McCullough, tuning processes will occur whilst taking both location and the activities of the place considered into account. Quite the reverse of that approach is one that considers pervasive computing to make everything possible all the time, tuning is related to the physical characteristics of the place. Those characteristics, including the activities, compound the persistent structure of form and environment that make possible both the process of tuning aggregations of portable and embedded technology. Without it, there would be chaos,

comments McCullough. The following table summarizes the tuning process, relating it to spatial circumstances and associated qualities. A comparison of all digital technologies components in a unique general table can be found on page 257.

	Territoriality	Privacy	Identity		Ambience
	Interiority and exteriority	**Visibility**	**Visibility**	**Appropriation**	**Appropriation**
Tuning the place .	The limits of an interior can be defined by more accurate tuning of the Ubicomp system.	Visible elements controlled by the Ubicomp system can be related to the process of tuning, thus affecting the level of privacy.	Limits defined by better tuning could be associated with visible marks, signs and emergency exits.	Tuning of the system can be regarded as the preferred way of balancing the Ubicomp system, thus becoming a factor of identity.	The 'tuning' process can be recorded in components that reveal people's appropriation.
	Example: Moveable enclosures can demarcate a crowded interior by 'tuning' its internal area with the number of people inside.	Example: 'Tuning' with the local activities can determine whether openness will be available according to the degree of privacy required in the scheduling of activities.	Example: Tuning is essential in the control of LCD displays embedded in glasses used to block sun light.	Example: A moveable structure can be controlled by tuning the efforts with the charges caused by its appropriation. Example: Carbon Tower project by Peter Testa. See http://archrecord.construction.com/innovation/2_Features/0310carbonfiber.asp	Example: The control of air can be achieved by tuning the openness according to the amount of Carbon Dioxide inside a room, as can be seen in the '*living glass*' project at http://www.thelivingnewyork.com/lg.htm

Table 14: Analysis and examples of spatiality of tuning process

3.5. The place as a referential matrix

As has been pointed out already, the elements of a place simultaneously make up its topological structure and represent the structure of the communicational phenomenon that exists inside the space. Thus, place itself, with its components, including the events, organized through the topology of the place may be regarded as the referential matrix that leads to the analytical view of this framework. This means that, together with the components of IT listed above, the place elements which topology represents - centrality, enclosure, directions, entrances and internal area - can be regarded as part of the solutions to interferences with interiority, visibility and appropriation, and consequently over the qualities. The analytical consideration of those elements here is the consequence of looking at then as something that can be assembled together in conjunction with IT in order to improve the qualities of place. The table used to analyse them corresponds to the original description in section 2.4 on page 47.

3.6. Using the tables

In order to clarify the procedural aspects involved in this framework, it is now worth doing a brief summary of the whole process, describing the use of tables to support the interpretation of the data collected. As has been seen, this framework is drawn up on the assumption that Information Technology can help to solve conflicts between spatial elements and the activities that happen in the places. The first step corresponds to reading space by observing *in loco* the way the activities happen and collecting all available data. Thus, by means of this initial step conflicts arising from the absence or malfunctioning of spatial elements relative to the activities of the people inside the place are identified. Once the conflicts are identified, a second analysis will study the ways in which the components of Information Technology can be assembled and specified in the design of Ubicomp systems. A third step is to consider which resources of IT are more appropriate to be specified in the design of solutions.

3.6.1. Identifying the conflicts in the place: the first step

A '*conflict*' here is not regarded as a social category, although it is possible to infer such a category by studying spatial conflicts. According to the original method adopted, (Malard 1992) a conflict is indeed an observable relationship between people and the spatial elements of a place. It specifies a condition inside of which the meaning of that activity does not happen; that means, a spatial element or condition needs to be provided to turn that activity executable without obstacles. Finding solutions to a conflict means providing the spatial elements proper to the meaningful occurrence of activities.

The observation of the conflicts is made through a process called '*reading space*', which consist of interpreting the spatializations of the activities in a place. Spatializations are the way people use and modify the space while using it. '*Reading spaces*' is a particular way of regarding the ordinary space as architectural space (Malard 1992). To read it, it is necessary to observe, directly and systematically, the way people cope with their activities in a place. This reading process includes interpreting all the available data, such as graphical registers, maps, plans, drawings, photos, annotations about the activities, and also interviews' records with users and so on. These will permit us to identify conflicts, describing and analysing them regarding the affected qualities of the place, namely territoriality, privacy, identity and ambience.

Table 15 shows a way of helping architects to do that analysis, and is used to organize the interpretation of the conflicts. By recording the observations and data collected *in loco*, the architect should interpret the evidences of the existence of conflicts, observing the activities and the designated spaces for them. Once one conflict is detected, the architect can determine how it affects the qualities of the place by analysing how the exteriority/interiority, visibility and appropriation of the place were affected. To do this more easily, the observations can be based on the topological components of the place (that means, its *enclosures, internal area, directions, centrality and entrances*), after considering how the spatial embodiments of that topology are affected by the conflict (that means, how the physical elements in the place are affected, like walls, pavements, fences, ground and floor elements, etc.). From this observation, it will be possible to infer which related quality of the place is being impaired. Thus, each conflict observed should be described, using Table 15 in a respective horizontal row which is divided in seven descriptive columns as follows:

Categorization/ name	Conflicts description	Affected qualities				Spatial elements	Documents References	Frequency (M,A,E)	Location (P,S)
		T	P	I	A				
a	b	c				d	e	f	g

Table 15: Table to interpret conflicts

a) Field to categorization or name of the identified conflict. It is a name given as in the expression '*spatial element X (versus) activity*'. According to Malard (1992), this ordination is to emphasize that the analysis should focus on spatial elements and activities only, avoiding interpretations that consider conflicts between two or more activities or considering the conflict as a social category only. *Activities* cannot be interpreted as being in conflict with other activities; otherwise the analysis does not reveal the missing spatial element. This way of describing conflicts (as '*spatial element X (versus) activity*') relies on the concept that activities are inseparable from the space in which they happen, as was mentioned in Section 2.4 on page 47. That totality is provided instead by the concept that architectural space is equipment, as Heidegger (1962) understands it. Once this is considered, the essence of equipment corresponds to what the equipment is *for*. In the case of architectural space, this essence is provided by the activities that take place inside it. Those activities are understood, in the first instance, as part of the dwelling process and, in the second instance, for specific *activities*. *Activities* in terms of conflicts correspond to the spatial elements that are missing or are malfunctioning when it comes to supporting them.

b) This field contains the description of the conflict. It consists of an interpretation of the evidence for the stated conflict. That interpretation is made based on documents gathered *in loco*, such as reports, photos, video-footages, and interviews with the users and so on. All the registers indicating the conflict may be regarded as important to the interpretive activity.

c) This corresponds to four fields to specify affected qualities of place. Once one conflict is described, it will be analysed in terms of how it interferes with *territoriality, privacy, identity and ambience*, by means of an analysis of how it affect the components of place (i.e., *enclosure, internal areas, internal directions, centrality and entrances*). More than one quality could be interpreted as being affected by just one conflict. The register of that interference is made by ticking one or more of the columns. The four categories of qualities of place are a means to simplify and organize the interpretive method and are based on an analytical ontology of the place as an organization given by the *interiority/exteriority, visibility and appropriation*;

d) Field to state the spatial element missing or malfunctioning. This corresponds to the realization that either a spatial element is missing or a spatial condition is obstructing the activities;

e) Fields to relate documents to the analysed conflict. These are organized by indexing the records of the conflict, and constitute the basis for interpretation of that conflict. They could be pictures, interviews, reports or other documents;

f) Field to interpret the frequency of the conflict. It reveals the period of the day time in which the activity is being affected by the conflict (morning, afternoon or evening);

g) Field of location of the conflict. Considering the possible existence of internal areas hierarchically organized in the place, this column tells whether the observed conflict takes place

diffusely or occurs punctually. This is meaningful when it comes to analysing urban precincts, as they can be taken to be portions of a bigger area.

An example of identification of conflict can be taken from the appendix named 'Fargate Project: Conflicts Report' on page 217. The first conflict described in that report was called '*Transient Protection X Lack of canopy in the entrance of shops*'. The first part is the shortening of the sentence '*the need of a transient protection*', which is an activity required in a full qualified experience in the street. The second part is the spatial element missing, which was deduced through local observations, new and historic pictures of the street. Thus, the field of the name of the conflict was filled.

Categorization/ Name of the conflict	Conflict Description	Affected Qualities				Spatial elements	Documents references	Frequency	Location
		T	P	I	A				
Transient Protection X Lack of canopy in the entrance of shops	**See text on page 220.**	x		x		**Canopies near facades.**	**Photos, Old photos, Local observation.**	**General, spread along the street.**	**Morning, afternoon, night.**

Table 16: Example of the use of the table in the identification of conflicts: Fargate Conflicts report.

In the field concerning the description of the conflict, a text (see on page 220) interprets the evidences observed, mentioning all the records which had helped in its identification. Basically this text explains why it was possible to interpret that conflict accordingly to the gathered records. According to that interpretation, a territorial problem was identified, concerning the need of transitions in the entrances of the shops and their '*reflected*' territory outside the shop, in the pavement. According to the interpretation the identification of the street as a commercial street was affected, that means, the conflict affected the local identity as well. Thus, the qualities of *territoriality* and *identity* were signed up in the respective column, and the spatial element was stated. The column related to the documentation corresponds to a simple description of documents used in the interpretation, which can be seen in the final report at page 220. Those documents include historical pictures showing how the canopies were important in the past, and actual pictures exhibiting people in the rain without any transient protection. Finally, the location and frequency of the conflict were deduced as being general spread and happening all day, and the two final columns were filled.

3.6.2. Studying digital technologies components spatiality: the second step

The second analytical step of this method corresponds to the study of the topology of the components of Information Technology located in the place. This study takes the view that, simultaneously, information interferes across the physical space and vice versa, permitting us to think about ways through which one component can be associated with the qualities of place.

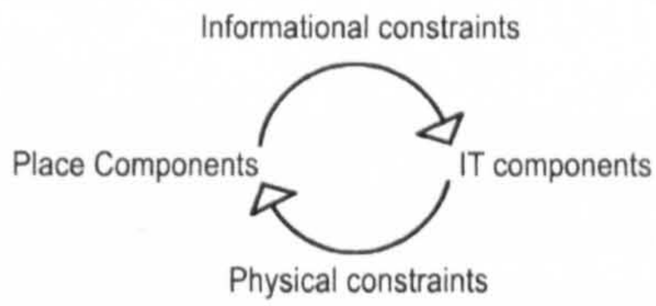

Figure 19: Analytical recursivity in the analysis of Ubicomp elements

Table 17 is an attempt to organize this study, casting some digital technologies components according to the classification of Ubicomp given by McCullough (2004). digital technologies components and the elements of the place (enclosure, centrality, internal area, directions and entrances) are, thus, analysed within the context of the same principle that is expressing their spatiality in terms of the same spatial conditions (interiority/exteriority, visibility and appropriation). Consequently, this will permit interpretation of how those components of Information Technology are related to the qualities of the place (territoriality, privacy, identity and ambience).

	Territoriality	Privacy	Identity		Ambience
	Interiority / exteriority	Visibility	Visibility	Appropriation	Appropriation
medium (a)	(b)	(c)	(d)	(e)	(f)

Table 17: Information analysed according to its contributions to the qualities of place.

In column "a", all the elements that are related to the information in the place are included. In order to facilitate this analysis, they were divided according to the type of interaction with the place:

a) Components to sense the place:
Microprocessors;
Sensors;
Tags;
Communication links;

b) Components to act in the place:
Actuators;
Processes of control;
Displays;

c) Components to represent the place:
Fixed locations;
Software models;
Tuning;

d) The place itself, with its topological components, as a recursive component within the components to represent the place:
Centrality;
Internal area;
Enclosure;
Entrances;
Directions.

The columns 'b' to 'f' in the Table 17 correspond to the characteristics of digital technologies components when interpreted as interfering in the place's qualities (*territoriality, privacy, identity and ambience*). Column 'a' may receive any new components that can be introduced by technological advances. The components of the place, when considered as part of the components of an Ubicomp system, are a recursive strategy that helps to reflect on the former components; in

other words those that represent the place. The digital technologies components and the place components are presented in the final table as follows:

		Territoriality	Privacy	Identity		Ambience
		Interiority / exteriority	Visibility	Visibility	Appropriation	Appropriation
Section A: **Components to Sense the place**	Microprocessors					
	Sensors					
	Tags					
	Communication links					
Section B: **Components to act in the place**	Actuators					
	Processes of control					
	Displays					
Section C: **Components to represent the place**	Fixed locations					
	Software models					
	Tuning					
Section D: **Place Components**	Enclosure					
	Horizontal directions					
	Vertical directions					
	Centrality					
	Internal Area					
	Entrances					

Table 18: Analytical Elements of Ubicomp relatively the place's qualities.

Section D is a correlation of the topological elements of the place with its qualities. This is obtained by reflecting on how those elements, when considered to provide interiority, visibility and appropriation, can provide territoriality, privacy, identity and ambience. This reflexive process endorses the hypothesis that the topological organization of the physical elements in the place is a matter of communication, so it can be treated in the same reflexive category as other digital technologies components. Naturally, for instance, the enclosure will be associated with the definition of an interior/exterior and a territory. It also does the same in relation to visibility, providing its control and interfering with privacy. The ordinances that those spatial components can assume in the place are a matter of the organization of the environment, seen in the light of information regarded as a consensual domain that has a similar structure to other linguistic domains (Maturana 1978, p. 48). As our concern is now with providing the means to simplify the task while specifying IT resources, that table can suppress the section D, which is an analysis already done by

assuming the ontology of the place by the topology of its elements (interiority given by enclosures, for instance).

In this framework, the table to analyse the components of IT in the place is presented in the appendix entitled 'Framework in 2007: Tables IT in place' on page 257 including all digital technologies components, and in the sections 3.2, 3.3 and 3.4 presenting each component in separate analysis. Following the same example given in the previous section regarding Fargate Street Conflicts Report, it was observed that the conflict named '*Transient Protection X Lack of canopy over the entrance to shops*' affected the qualities of *territoriality* and *identity* (see section 3.6.1 on page 69). Thus, those qualities will drive the choice of one or more digital technologies components, by observing in the table which components are related to *territoriality* and *identity* and how their spatiality can be interpreted. Once they were chosen, they can be specified to help the creation of a solution to the conflict.

3.6.3. Specifying IT resources to the conflict solutions: the third step

Of course this framework is not a mechanist method that automatically provides a solution just because those previous tables are supporting the process of thinking about Information technology in the space concerned. Actually, the whole process consists of thinking about information in the space and ways to figure out spatial relations through the information exchanged in the activities. Once again, it is possible for those tables to provide support, even considering the flexibility implied in any process of design. Also, the cultural and personal variables should be considered while analysing conflicts in a place. Those variables, despite the stability provided by a cultural set, can enrich the interpretation of the conflicts by considering peculiarities relate to individuals or groups that use the place. These subtle observations should be considered while using the tables to interpret conflicts.

The first table presents a conflict that can interfere, for instance, in the qualities of territoriality and identity, the second table gives an outlook on components that are related to those same qualities. This means that the architect can create a solution to the conflict referred to by using the components specified in the columns for territoriality and identity. This process of interpretation is still very open, but is now supported by systematic reflection and rational interpretation.

For instance, considering the example of the aforementioned conflict identified in Fargate Street, within the table to analyse digital technologies components in the place, it is possible to observe that '*actuators*' can affect the territory by opening or closing elements of enclosure, adjusting it according to specific local requirements (for instance, movable ceilings and canopies, floors, internal directions, fences, delimiters, all in the form of servomechanisms). They also affect the identity when are used as visual identifiers, clarifying what are the elements of local identity according to the schedule of activities in the place. When providing adjustments of physical elements according to the conditions demanded by user's occupation, they can also be related to appropriation, affecting local identity. Another component of IT that can be observed affecting both '*territoriality*' and '*identity*' is the '*sensors'*, elements to sense the territory and users' behaviours.

According to the previous observations regarding '*actuators'* and '*sensors'*, architects involved in the search of solutions to the identified conflicts can, for instance, suggest the design of interactive canopies which shapes could help in the visual identity of the street. Their project could consider that retractile canopies would be interactively connected with simple sensors of weather conditions, providing temporary sheltering to the pedestrians and avoiding interfering in the visibility of the facades. This solution, anyway, could be shared with others ways to deploy IT aiming to solve as

many identified conflicts as possible. For example, the canopies could have links that permit Bluetooth connections to be established in the territory demarcated. Those connections could inform by mobiles and other devices about services and products, as well historic information about the shop, the building and the neighbourhood. According to the example given throughout the steps to use the tables, it is clear that the suggested strategy do not represent a mechanical method to provide solutions, but rather a way to connect the creation of design solutions with a systematic reflection regarding probable improvements in the place by the deployment of digital technologies components.

Since the framework has been introduced in Chapter 2 and accomplished in this chapter, it can be summarized as an attempt to organize the reflection about the use of IT to solve conflicts, providing elements to inspire design solutions aiming to invigorate the qualities of the place concerned. Thus, next step will be examining how architects can use this framework and how much it will help them in the creation of solutions. However, before describing situations where the framework was tested, it will be helpful to understand the adopted methodology to study the application of the framework, justifying and characterizing the methodological choices. This is the subject of the next chapter.

Chapter 4:
Methodology of Research

Chapter 4:
Methodology of research

As many authors have pointed out, the key step of research is in fact the very starting point for the creation of a plan to guide the process of collecting, analysing and interpreting observations in the research project itself (Hakim 1987; Allan *et al.* 1991; Frankfort-Nachmias 1992; Popper 2002; Yin 2003). In this sense, the analysis of the key questions generates a logical model of proof that allows the researcher to draw inferences concerning causal relations among the variables under investigation, thus guiding the whole research. Therefore, conducting an analysis of the key questions prior to the beginning of a programme of research can also suggest important clues regarding the relevance of the strategies to be adopted in the composition of an effective method. Also the analysis of the research propositions can direct attention to something that should be examined, helping to outline the investigation. Thus, in order to introduce the methodology, this chapter will start with the examination of the key questions and the general design of the research, unfolding the latter in more detail under topic headings in order to clearly justify and explain them. An account of case studies will be introduced after this, and the validity of these in terms of the scope of this research will be established. Finally, an account of the analysis of data will be introduced, in order to generate valid interpretation criteria.

4.1. Key questions and initial considerations

After my participation in the Gwangbok Street Project in 2005, my first attempt to create a theoretical approach included in its scope some concepts that I had used as a research investigator in Brazil. Among others, there was the idea that open public areas could be considered as having the same qualities that architectural interiors have. This meant that they could be regarded as '*exterior*' places with the qualities of internal places, and this insight corresponded to a broadening of the theory developed by Malard (1992), which had originally regarded only the interiors of houses. Other concepts which I had utilised in a non-systematic manner in the Gwangbok Project (see on page 205) were also included in that first framework, for instance, the classification of digital technologies components according to the taxonomy outlined by McCullough (2004). A bibliographic review supported that theoretical construction by updating the notions of place and providing more information about the characteristics of digital technologies components.

After a period that corresponded to my first year of research, the first version of the framework was ready. Then, to test that initial framework, five postgraduate architects students used it in the creation of a project for the urban requalification of Fargate Street, in the city centre of Sheffield, UK. Those architects were students of the discipline known as "*Interactive Urban Visualisation Modelling*", which featured in the Master's degree course in Architecture at the University of Sheffield during the spring semester of 2006. Through the observation of the results of that first application of the framework in an actual project (see on page 245), further questions regarding both IT and theories of place were raised for investigation, and as a result, the framework was expanded and refined.

This refined framework involved the inclusion of a more accurate specification of technical properties of digital technologies components and a study of those components, relating them to the topology of the place concerned. However, and perhaps most crucially, this framework was distinctive in the way that it consistently emphasized an interest in the better understanding of the use of IT in urban places from an architectural standpoint. In addition, new summarizations, addressed specifically to architects, were drawn up in order to provide clearer ideas about the concepts underlying the theory. Then, after one more year, during the spring semester of 2007, the framework was applied in a second situation, by the students of the aforementioned discipline. It was used by two teams, each composed of 5 architects students, to develop two projects for the urban augmentation of the concourse area of the University of Sheffield campus (see on page 267 and on page 295).

As it can be deduced, the initial analysis of the key questions in this research led to the design of a plan for the conduct of the whole inquiry, whereby what was demanded, first and foremost, was the development of a theory prior to the collection of any data for the research. The correlation between the adopted framework and the projects resulting from the application of that framework gave the research more information about its characteristics. The amendments of the theoretical framework were made by the modification of points that have been identified as those that did not permit the architects to unfold their understanding of IT and the place at certain defined levels – for example, their skills in identifying and analysing problems and abilities to synthesize and evaluate solutions. Thus, all this means that the construction of the framework and the criteria used to test it were settled in the first instance by the research plan in the form of a multiple-case study, through which the theory, its characteristics and development, could be better observed.

As a reference to this latter point of view, Yin (2003) points out that the plan for case studies can include the prior development of a theory as a feature of the initial design of the study itself. Referring to this, he advises the research investigators that:

> *"The complete research design embodies a 'theory' of what is being studied. This theory should by no means be considered with the formality of a grand theory in social science, nor are you being asked to be a masterful theoretician. Rather, the simple goal is to have a sufficient blueprint for your study, and this requires theoretical propositions, usefully noted ( ) as "a hypothetical story about why acts, events, structure and thoughts occur.( ) The complete research design will provide surprisingly strong guidance in determining what data to collect and the strategies for analysing the data. For this reason, theory development prior to the collection of any case study data is an essential step in doing case studies" (Yin 2003, p.29).*

Thus, in this inquiry, the development of that related theory is regarded as essential, and although the case study method was not the only available means of testing a theory, it was considered to be a coherent strategy for the pursuit of conclusive issues regarding the key questions. This means that the case study method was reckoned to be a strategy to develop and test the theory by means of the situations described previously. Therefore, together with the Gwangbok Contest Project, the

applications of the framework by the architects in the discipline of the master course were considered here as unities able to provide the cases with analytical delimitation.

The comparison of the resultant projects from those cases permitted a systematic scrutiny of some of the characteristics of the theoretical framework. Consequently, the refutation or ratification of the theory and other problematic points were made possible observing the attempts of the architects to apply the framework during the design process. The way the architects demonstrated their skills to identify problems, analyse them and provide a synthesis of solutions by employing IT was the means of acquisition of more information about the characteristics of that framework, as well as giving an analytical account of the points demanded of its development.

In other words, the cases that will be studied in this inquiry comprise all those circumstances in which the architects have applied the framework to the design of IT supported urban places. The Gwangbok Project, for example, represented one such circumstance. Here, the architects used few theoretical elements, whereas in the two other situations, in the projects to Fargate Street and Campus, a particular theoretical framework was developed to support the application of IT in urban places. The test for the framework consisted of the observation of its use by architects in the identification of spatial problems, their analysis and the creation of solutions that incorporated IT as ubiquitous systems, and their abilities in this respect were expressed in the graphical outcomes of their projects and in the supplementary written rationales that were supplied to back these up. Additional information was obtained by their observation during the review sessions. Thus, with distinctive moments being regarded as cases to be studied, the research design gained a sufficient degree of character enough to allow its evaluation.

The evaluation of any research design is made possible by using some tactical analysis to judge distinct phases that correspond to the moments at which the key questions and the research design itself were formulated, and to the phases of data collection and data analysis (Yin 2003). Despite the design function of a research being virtually invisible during the actual execution of a project, it becomes more noticeable where an account of a theoretical development is concerned (Hakim 1987). Since this latter situation corresponds to this research, the next section will examine the definitions of case study and the validity of the design of this research by analysing its coherence phase by phase, as well as justifying the adoption of the method by characterizing its particularities in the specific context of architecture.

4.2. Validity of the research design

In view of the natural sequence of reasoning developed in the previous section, it makes sense to analyse the research design before describing which definition of case study method is adopted in this inquiry.

Research design is supposed to represent a logical set of statements describing the procedures adopted in a research. Consequently, it can be tested by judging those statements on the basis of certain sets of logical tests. Yin (2003) mentions that, in the past, those logical sets gave credits to such qualities as trustworthiness, credibility, confirmability and data dependability. However, nowadays there are four tests commonly used to establish the quality of any empirical social research: *the construct validity test*, *the internal validity test*, *the external validity test* and *the test of reliability*. Since case studies represent one such form of this kind of research, those tests must

necessarily be relevant, and in this subsection those tests will be examined within the context of the inquiry. However, it must be stressed that this examination is only possible retrospectively, when the phases of the research have passed, since each test is relative to a specific phase that sometimes cannot be not clearly defined during the research period.

It will be worthwhile summarizing the research design of this inquiry before testing its validity. As has been seen, the design was derived from analysis of the key questions, which demanded a strategy to study the characteristics of a theory that could help architects when they are applying IT in a project concerned with urban places. Then, an initial theoretical framework was developed that considered the place theories and the IT characteristics, the application of which in the design of an IT-supported urban place was considered a reasonable strategy for testing the efficiency and revealing the characteristics of the theory. Furthermore, the theoretical refutations generated by that first application could provide amendments and contribute to the refinement of the framework. When the test was replicated on a second occasion, again with reference to an urban place project, it enabled some points to be confirmed and other modifications previously made to the framework to be discarded. In other words, the design of this research comprehended multiple cases that corresponded to the three occasions when an urban place with IT applied was designed with the support of the framework. On the first occasion – in the Gwangbok Project - it was observed that the effect of non-existence of a prior structured theory to help the architects in the use of IT was observed. On the consecutive occasions – the Fargate Street project and the Campus project – a framework was developed prior to the projects in order to help the architects.

The three aforementioned instances, with their respective theoretical reviews, exemplify the basic procedures for the design of this research, and now that this basic design has been defined, it seems reasonable to proceed to a test of the validity of that design.

4.2.1. Construct validity

The first test of the research design has to focus on its *construct validity*. This means that what should be verified is whether the correct operational measures for the concepts that are being studied in the research have been established, thus eliminating "*subjective*" judgements in the collection of the data. It also corresponds to a previous definition of what kind of data is important. The first tactic to be employed to this end is the observation of whether multiple sources of evidence were used, in a manner encouraging convergent lines of inquiry (Yin 2003).

The subject that is the focus of this research is the development of possible theoretical approaches to support projects for urban places using IT, and the objective way of measuring that development would be the observation of the improvements made to a framework initially created and tested by being applied in similar projects. In turn, the best way to observe the improvements in the framework is to analyse the resultant project in light of the issues originating in the application of the framework itself. This takes the form of the analysis of the graphical material that represents the solutions provided; that is to say, it involves the analysis of the ideas and intentions expressed graphically by the architects while addressing themselves to the problems that they tried to solve with the use of information technology applied in the place. Specifically, this means taking a close look at their drawings and respective rationales.

Those previous definitions demonstrate that, for the construct of this research, the analysis of resultant projects as applied to urban places, together with the development of a theory (including its criticism and improvement) and the direct observation of the architects through review sessions are all means of offering convergent data to enable the understanding of the central question at the heart of this investigation; in other words the kinds of methods and tools that can help architects

when they are designing the use of IT in the places. This reasoning discards, for instance, the idea of giving only credence to the analysis of real and built solutions as a means to investigate the key question. Indeed, it is worth stressing that if that approach were valid, then research would be prohibitively expensive to conduct, in consideration of either the necessity to build the projects arising from the same theoretical view, or the need to find identical theoretical backgrounds supporting different built solutions. In any case, the greater likelihood is that in both situations, the same or less valuable data would be found, whereas the concern here is for data related both to the real intentions of the architects and to the ways in which their theoretical approaches have interfered with their designs.

A second tactic to test the *construct validity* is to establish a chain of evidence, also relevant during data collection (Yin 2003). When a chain of evidence is successfully achieved in the data collection, analysis and organization, it permits an external observer – the reader of this research, for example – to trace the derivation of any evidence, ranging from initial research questions to ultimate case study conclusions. In the case of this research, it is both justifiable and possible to include all the material that constitutes the main source of data for the research, such as the project drawings, rationales and reports. Therefore, at any time, simply by consulting the provided appendices while reading this research, the reader can obtain the reference attached to a mentioned source, and is thus able to follow the arguments and see the evidence that supports them.

The third tactic mentioned by Yin (2003) is to have the draft case study report reviewed by key participants and informants in the case. The central idea here is that this approach would enrich the process in many ways, since it enables reviewers to recall facts, identify instances where information has been mistaken and correct other problems. Methodologically, the corrections made via this process enhance the accuracy of the research, and hence increase the *construct validity*. Furthermore, in the context of this research the supervisor is regarded as having played a role as important as such a reviewer, since he has observed all the experiments and overseen the discipline with which the application of the framework was conducted; through his supervision this report has been reviewed and the mistakes in the data collection minimized. Moreover, throughout the whole period of the module of "*Interactive Urban Visualisation Modelling*" and informally in the reviews, it was possible to exchange information with the participating architects in order to revise the theoretical framework. This tactic will be given further consideration observed in the Chapter 8, on page 174.

Therefore, considering the preceding arguments, the test applied to the construct of this research has provided conditions that allow it to be considered a valid construct, according to the availability of diverse convergent data, the possibility to concatenate and link all the evidence from an external point of view and the impartial review of this report made by a key observer.

4.2.2. Internal validity

Another criterion for testing the validity of the research design concerns checking its *internal validity* (Yin 2003). *Internal validity* is of concern only to exploratory (or causal) investigations, and it is mainly related to the phase of data analysis of a research; in other words the very moment at which some inferences ought to be made. Every time an event cannot be directly observed, it results in an inference by means of the establishment of causal relations with other observed events, the validity of which could be checked by asking simple initial questions like:

- Is the inference correct?
- Have all the rival explanations and possibilities been considered?
- Is the evidence convergent?

- Does it appear to be airtight?

The *Internal validity* test consists of the observation of causal relationships whereby certain conditions are shown to lead to other conditions, as distinguished from spurious relationships. Thus, the process of reasoning about causalities demands consideration of two aspects: first, to make causal claims, an investigator needs, for example, to determine that one event led to another predicted event without the interference of hidden circumstances, i.e. that the inference is free from interferences. Second, the concern about this purity may be extended to the broader problem of making inferences in the research, as they are made every time causal events cannot be directly observed. Yin (2003) comments that, in order to set in place a valid background to analyse data collected in a research, four tactics may be adopted to test its *internal validity*: pattern matching is the first strategy, followed by explanation-building; then rival explanations ought to be addressed, with logic models being used at the very end.

Pattern Matching is a kind of logic that compares an empirically based pattern with a predicted one or with several alternative predictions. If patterns coincide, the results help by strengthening the *internal validity*. In this research, a pedagogical model was used as a means to offer some patterns to observe the understanding of architects when they used the developed framework to support their projects (see 4.5 below). That model is the taxonomy of educational objectives developed by the educational psychologist Benjamin Bloom (1956). According to him, the learning process implies the commitment of the learner in three domains: the "*affective domain*", which refers to the engagement of the attention levels; the "*psychomotor domain*", which aggregates the abilities to physically manipulate a tool or instrument; and, finally, the "*cognitive domain*", which refers to specific knowledge of facts, dates, models of natural rules, and so on. This latter domain specifies what can be observed in the process of understanding, and for that reason it constitutes the starting point for the formulation of the expected educational outcomes in a discipline. This means that, during the application of the framework to the Master's Degree course, the performance of the architects was observed with patterns typical of the cognitive domain in mind. These patterns have been classified by Bloom as levels of understanding and they represent the three main stages of project-making: identification of the design problem, analysis of the design context, and synthesis of a solution. By expanding those three activities in more accurate categories, they can be expressed as expected outcomes in the levels of knowledge, comprehension, application, analysis, synthesis and evaluation. Thus, each level provided a means of enunciating what was expected when the framework was used by the architects, simultaneously assessing their performance and analysing the projects and respective rationales. The appendix entitled 'Campus Project: Educational Outcomes 2007', on page 262, presents some expected outcomes that were used as patterns to analyse the projects resulting from the application of the framework in the master course in 2007. Those outcomes were expressed as the architects' understanding of the place, of digital technologies components, their analysis of the place (which comprised the detection and the interpretation of conflicts between local activities and missing spatial elements), and finally the production of a synthesis of solutions (comprising the plan with regard to the IT system, the specification of the physical changes and the specification of the features of the IT system created). The presentation of the solution elucidating new scenarios was supposed to allow the observation of their skill in evaluating their own systems.

Explanation building is a second analytic technique for verifying the *internal validity* of a research design. The goal of this process is to analyze the case study data by building up an explanation of the case. It corresponds, in this research, to the descriptive procedure which narrates the three circumstances where the framework was applied in projects and is conducted on the basis of the observations of the research investigator (see Chapter 5, Chapter 6 and Chapter 7 below). Thus, the validity of the narrative is verified by checking its plausibility, precision, clarity and logic. Also, when the three cases are considered together to be analysed in Chapter 8, inferences relating to the time expressed in the narration of the cases can be observed and checked by reference to its

precision; in other words by consulting those narrations that concatenate sequences of events, or set intervals to their occurrences, establishing time periods related to the observed phenomenon. As far as this research is concerned, the feedback for each application of the framework was made during a period of refinement, and this resulted in new concepts and better explications of the design of IT use in places. The setting of such time periods and the chronology to support the discussion of the research was essential to providing an understanding of why some modifications had been done and what were their causal links.

Like the latter, addressing rival explanations is another way of checking the *internal validity* of the research every time a construct explaining inferences is required, and, for this reason it can be regarded as a form of explanation building. In terms of this research, most of the rival explanations are constructed, to a certain extent, by the negation of the assumptions derived from the key questions. For example, in the composition of the framework, it was shown that in some theories of IT the issues relating to physical space were reduced nearly to irrelevance. All those theories can be considered as '*rivals*' in the analysis of the data, because according to the framework, the physical aspects of the place and its topology were exactly the determinants of the design for the use of IT in the place concerned.

Using Logic Models is the fourth technique used to bolster the *internal validity* of a research. As an analytic technique it consists of matching empirically observed events to theoretically predicted events. Conceptually, it is another type of pattern matching, but, due the sequential stages required in the comparison of patterns, it differs from that technique, once the phenomenon is compared with a whole model. In this research, however, the educational model concerned with the various levels of understanding derived from the taxonomy of educational objectives (Bloom 1956) permitted it to be taken as a logic model (see Table 19 below) that would guide the didactic process and introduce the framework to the architects through a series of lectures and tutorials, as well as serving to guide the observation of that module in the course, allowing the ways in which architects' behaved at the point of the application of the framework to be distinguished.

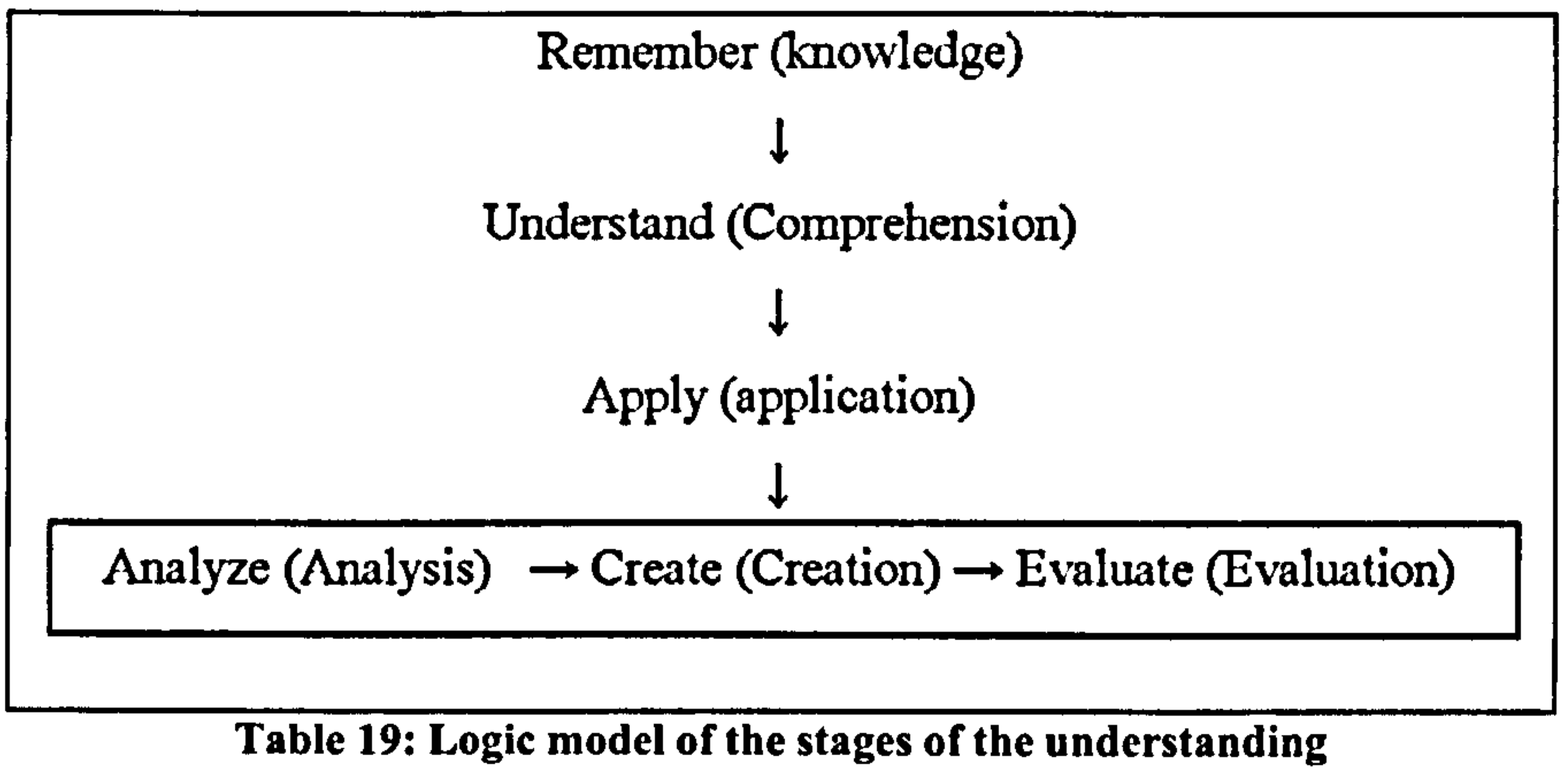

Table 19: Logic model of the stages of the understanding

Thus, according to the model, the application of the framework, for instance, comprised two distinct moments corresponding to the process of apprehension of the theory and the process of rearranging that knowledge in different situations.

4.2.3. External validity

With respect to the importance of the research findings, which regards the generalization of conclusions to circumstances beyond the cases from whence they were derived, the *external validity* test demands the establishment of the domain in which a study's findings can be generalized. In this research, to observe that generalization, the adopted tactic was the replication of the case of 2006 in another class, in 2007, after refining the framework. This consisted of the replication of the circumstances when the framework was previously applied, and the observation of those different situations led the research to focus on multiple cases in order to generalize the findings about the framework better. The diversity of those cases, in terms of the difference among them, enriched the generalizations and demonstrated a valid range to generalize characteristics about the use of the proposed framework.

4.2.4. Reliability

The *reliability* test demonstrates that the operations of a study, such as the data collection procedures, can be repeated with the same results. In this research the collection of data corresponded to gathering data from the works produced by architects. Once the operations were absolutely regular, so as to be repeated with different groups of architects in other classes of the module "*Interactive Urban Visualisation Modelling*" in the Master's course, the possibility of repeating the circumstances is deemed to have been demonstrated.

4.3. The observed phenomena

Some points have been derived from the analysis of the key questions, and it is worthwhile summarizing these points now. Firstly, it was observed that a theoretical framework concerning the design of Ubicomp systems should be developed prior to implementation, and then tested in situations where it would be applied by architects in the design of IT use in urban places. Those situations were the exercises in the "*Interactive Urban Visualisation Modelling*" module taken from the Master's course in Architecture at the University of Sheffield, which ran during the spring semesters of 2006 and 2007. It was observed that, together with the Gwangbok Project, those situations could be considered as cases to be analysed by applying the case study method. Then, before the concept of the case study method was defined, descriptions and accounts of following were provided: the reasons for considering the research design valid; the kind of data that was considered important; how it was collected in each case; and, finally, how that could be related to the improvement of the overall theoretical framework. Now, this section will examine the peculiarities of the observed phenomena and their contexts, with the aim of providing a concise reference within the general context of the research itself.

It was mentioned earlier that one of the reasons for adopting the case study method was the fact that that this method can provide a test of theoretical propositions by observing whether or not the derived predictions occur in the design process. Thus, regarding the development of a theoretical framework, the application of that framework in urban projects by architects was considered an effective test. It was to be expected that, through those applications, correlations established within

the theory would be visible and analysable, notably those correlations between the spatial elements of the urban place, the activities lodged in it and the flux of information that takes place there. The validity of such correlations would reside in the degree of, whereby, through the execution of the project, they permit to the architects to describe, explain, and predict events and results. In other words, it was clear that the observation of the logic used to build conceptual constructions to justify the project would be a tool to observe the effectiveness of the aforementioned correlations. Initially, three sources were considered for the purposes of checking that logic: the observations of the architects working during the design, the final analysis of their projects and the analysis of the rationales they provided for their projects.

But, in a process of investigation, the attempt to promote theory development by means of testing derived propositions lacks the particular characteristics that can unequivocally endorse the choice of case study method. As a matter of fact, the test of predictions made by the application of a theory, lies at the heart of all research processes (Frankfort-Nachmias 1992), as is shown in Figure 20. This means that the fact that it is possible to test a theory within a research neither justifies nor specifies the adoption of a particular case study method.

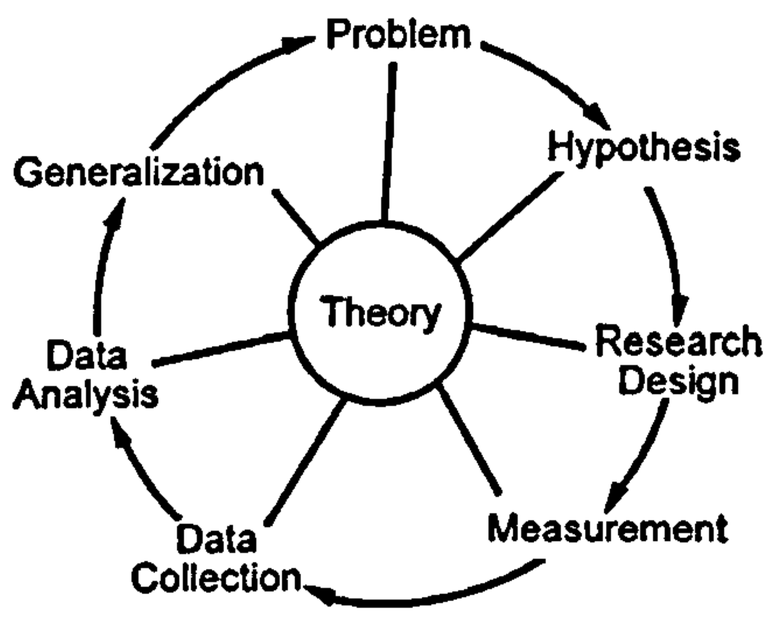

Figure 20: The main stages of a idealized research according to Frankfort-Nachmias (1992). The continual development of the theory turns that process in a cyclic test of the generalizations and self corrections of the theory.

Then, to properly clarify the reasons why the case study was chosen, attention should be given to a broad analysis of the relationship between the observed phenomenon, its background and the means of observing both. An initial conclusion that arises through this analysis is that the phenomenon under consideration - namely *the development and application of a framework to support architects in the design of Ubicomp systems in urban spaces* - can only be regarded as being divorced from its context - that is to say, *the design process where that framework was used as a support* - with great difficulty. This means that, at first sight, it was considered a coherent approach to observe the architects at work, designing the project. That observation could get clues about the characteristics and limitations of the framework that they were using. However, despite the informative nature of the process of observing the architects' behaviour, it did not amount to a satisfactory strategy for observing the framework itself, with a strong focus on its potential to represent reality and to permit the manipulation of that representation.

Although observation of architects' behaviour could reveal unique aspects of their *modus operandi* while using the framework, the analysis of the way the architects used the concepts and representations given by the framework should take place when their final projects are scrutinized. As a conceptual construction, a framework introduces concepts structurally organized so as to permit the analysis of problematic situations. In the case of this research, the elements of the place, its topology and the components of IT are represented by those concepts, and through the analysis of those elements, it unfolds conceptual sets that aim to support the creation of solutions,

specifying the use of IT devices and IT applications in the place. The behaviour of architects, while they were creating solutions with IT, can reveal how easily they could grasp the concepts and communicate among themselves in order to make operational decisions about the design. Nevertheless, this cannot be taken to be the only phenomenon to be observed in order to study the framework and characterize its applications, and the reason for this can be explained by the examination of the way in which architects normally deal with theories and their application in design processes.

During the application of the framework, while the architects were designing the projects, they had meetings with the research investigator in order to clarify questions and concepts about the framework. At these points it was possible to observe evidences and make inferences about the framework application and architects' behaviours. For instance, it was possible to identify difficulties that some teams of architects had, while doing the Project and using the framework. However, the project decisions were taken by the architects after the reviews that took place throughout the semester, and it was this that made it impracticable to continuously observe their reactions towards the use of the framework. Also, the discussions of the decisions taken, during the reviews, revealed only a few points about the repercussions of the framework over the course of the project, saying more with respect to the discarded options than anything else.

Christopher Jones (1970) has formulated some concepts that can be helpful in understanding the behaviour of those architects, and also in understanding the delimitations that exist between the observed phenomenon and its context. Jones studied many design theorists and concluded that, regarding creativity, a designer can be observed as acting in three general ways while creating: as a *black box*, as *a glass box*, or as a *self-organized process*. Despite many criticisms about Jones approach, those three definitions, at least, can illustrate the complexity of the observed phenomenon

As a *black box*, nothing can be known about the designer and the origin of the ideas that guide him/her; the reasons that drove him/her towards a set of decisions or solutions exist under an absolutely impervious blanket of obscurity, inside his/her mind. What can be actually examined in this case is only the problematic situation that generates the result, called "*inputs*" by some authors, and the result itself, sometimes called "*outputs*". The '*black box*' theory is a legacy of cybernetics studies (Broadbent 1973), and it was defined as a method to deduce the functioning of an unknown process by its external analysis, observing how some inputs and outputs are correlated. In wartime, the '*black box*' analytical method was essential in deciding what should be scrapped or what was worth returning for repair, in instances where opening or dismounting equipment was dangerous or prohibited. It was used, for instance, in the maintenance of bomb sights, which, in order to help ensure technology secrecy, were inspected without being dismounted.

However, the designer can also behave as a *glass box*, which means that he/she can reveal transparently all the mental process during the design phases. Thus, according to this view, the design is entirely explicable, even if the designers are unable to give reasons for the choices they have taken. To act in the way the '*glass box*' model anticipates, however, the designer should have pre-established criteria to guide the design decisions. For this to occur, he/she must have objectives, variables and criteria for the design, fixed in advance: the strategies of design must be pre-determined; and he/she must also have completed the analysis of the design problem before a solution is sought. The evaluation of the design problem is mainly logical and easily explicable; the process looks completely linear, rigid and rational. However, the main criticism is that the anticipation caused by the admission of a non-modifiable theory is an imposition of a methodological grid over the reality, thus depriving it of richness and causing questionable results.

Finally, when viewed as a *self-organized system*, the designer neither imposes him/herself as a guide to design nor acts out of his/her rationality, but organizes him/herself in order to cope with

the design problems taking into consideration the need for a flexible strategy, and is able to provide a dynamic revision of the adopted methodology, including the architects' intuitions. In short, *self-organization* implies a conjugation of the *black and the glass box processes*.

When the observed phenomenon of this inquiry are analysed using Jones classification (Jones 1970) it can be said that the architects have adopted a behaviour oscillating between the black and glass boxes and the self-organized process, during the application of the framework. In others words, sometimes they behaved as black boxes and it was not possible to observe the logic of their process of creation. However, sometimes, during the reviews sessions, it was possible to observe that they made it clear that their decisions were based on the frameworks' concepts and they discussed the reasons why. This situation made it difficult to separate the observed phenomenon from its context during the data collection and analysis, which, in turn, means that there was a problem with considering the process of the application of the framework in isolation from the projects that resulted from it. Consequently, it suggested that, in order to overcome those occasions when they behaved as black boxes, a participatory observation of the research investigator through the reviews sessions should be adopted, as soon as that observation could reveal more correlations between the theory and the results of its application by the architects. It also means that the clearest way of observing how the framework was reflected in their method was by the analysing the final results of the design, which means, comparing the resultant project with some initial requirements.

It has been shown that it would be difficult to disentangle the phenomenon from its context in the attempt to achieve an integrated view of the phenomenon observed in this research. This situation is characteristic of instances where the case study is a suitable. On the basis of one of its formal definitions, the case study method can be regarded as "*an empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident"(Yin 2003, p.13).* General research methods can cope with experiments by isolating the respective phenomena and observing them in a controlled environment. As far as this research, however, is concerned, a certain dynamism is required in order to observe the particular phenomenon – i.e. the use of a framework by architects while doing a project – and it is this that has prompted the suggestion of a methodological alignment with case study strategies. This means that the process of doing an urban project - including all those common circumstances, like group discussions, personal interpretations, particularities and individual skills - can not be considered as a plan with pure phenomenon that can be isolated and studied in a laboratory. The case study method, therefore, was a response to the deliberate intention of covering all those different contextual conditions, in the belief that they might be highly pertinent to the understanding of the characteristics of a framework for the design of Ubicomp systems in places.

4.4. The choice of case study method

In the last section a definition of case study method by Yin (2003) was seen, which will now be expanded and contextualized. This account of the characteristics of the case study method will permit a justification of its adoption while elucidating contextual particularities.

In terms of this research the case study is a strategy that is based on the observation of a recent phenomenon within its real-life context, mainly when the limits between that phenomenon and its context are not clearly evident. In endorsing this concept, Yin (2003) points out that the case study can be regarded as a method that is deliberately chosen to cover such contextual conditions, such as

the entangled relations of the phenomenon with its context or the presence of many more variables of interest than data points. The case study method is mainly a method that allows investigators to retain the holistic and meaningful characteristics of real-life events while analysing a specific phenomenon. As was mentioned in the previous section, for this research, the observation of the theoretical framework in the context of a design process requires such a holistic approach, so as to avoid the reduction of the possible correlations between the many variables involved in the scenarios analysed.

According to Yin (2003), the peculiarity of analysing phenomena that have complex relations with their contexts further distinguishes the case study method from other types of inquiry like experiments, histories and surveys. For instance, an experiment focuses on only a few variables, deliberately divorcing the phenomenon from its context, using a laboratory environment to control the variables better. A history, meanwhile, takes contextual relations with the phenomenon into consideration, but usually deals with non-contemporary events by analysing documentary records from the past. Surveys, on the other hand, have an extremely limited ability to investigate contextual relations, once there is a concern for limiting the number of variables to be analyzed in order to fall safely within the number of respondents that can be surveyed.

Thus, the case study method was considered an appropriate tool to observe situations where the phenomenon and its context were hard to separate analytically. It has been justified in the previous sections that the phenomenon in this inquiry - which is the development and application of a framework in the design – was difficult to separate from its context - which is the design process where that framework was applied – and the case study method was regarded as the appropriate methodological approach, together with a participant-observation during the reviews sessions conducted by the research investigator.

4.4.1. Case study definitions

A brief search through the literature concerning the definition of the case study method can reveal, however, that this methodological approach is difficult to characterize and requires an extensive combination of appropriate criteria to filter the relevant data, as well as a kind of analysis that is able to accommodate both the observed phenomenon and its context. One reason for these problems is that there are many definitions of the term because of the many different fields that use the '*case study*' but which may in fact be characterizing quite different strategies. Some of them, for instance those in the social sciences, present a broad discussion of the purposes of the case study method and specify its procedures, as it can be seen in Yin's work (2003), which is adopted by this research because of its contextual applicability to the field of architecture.

Other fields, focusing on research education, have extended the importance of case study to learning methods, as in "*Learning from case studies*" (Easton 1982), but that approach is emphatically committed to the analytical purpose of that kind of study, pushing aside concerns about the collection and analysis of data, since its application is restricted to produce exercises for students. Alternatively, focusing on construction, design and management in architecture and engineering, case studies are presented as a systematic description, as is suggested, for example, in the work "*CDM regulations - case study guidance for designers*" (Arup 1995). But in this latter example, as well, the restriction placed on the application of the method, which focuses on its descriptive purpose, weakens the other characteristics, such as its functions in exploratory and explanatory approaches. Those three purposes – exploration, description and explanation of phenomenon - should be considered as general characteristics directly related to the research questions more than to the fields of research.

All this great variety of conceptions around the term naturally brings about a discussion of the scientific validity of the case study to some research scenarios. Although the case study is a distinctive and useful form of inquiry, there is some criticism which must be rebutted in order to consolidate the choice of that method for this research. Basically, three general complaints against the case study strategy are worth observing and refuting. These concern scientific rigour, scientific generalization and the duration of the research.

4.4.2. General complains and their rebutting

The first complaint against case studies is that they normally lack rigour, since many of them have either failed to follow systematic procedures or have allowed equivocal evidence or biased views to influence the direction of the findings and conclusions. This happens because sometimes cases studies destined for teaching purposes are confused with those aimed at research. With regard to the teaching functions of case studies, Easton (1982) mentions that a case study is basically a description of a situation with a problem, gathering together all sort of evidence in order to exercise analytical skills concerning the problem, applying concepts and principles and creating alternative solutions to the problems uncovered by logical analysis. However, Yin (2003) makes a distinction between case studies regarding the learning process and those regarding research. For teaching purposes, a case study need not contain a complete or accurate rendition of actual events, since its purpose is to establish a framework for discussion and debate among students. For research purposes, however, case studies need a rigorous and fair presentation of the empirical data. In the context of this research, that presentation covers the four projects resulting from the three cases (Gwangbok, Fargate and Campus), supplemented by their rationales. It is possible, then, to keep those data records and to analyse them in the light of a model of understanding derived from the one Bloom (1956) used in his educational taxonomy, as was initially suggested in section 4.2.2 as a way of justifying the of Internal validity of the design research. That in turn corresponds to determining how the architects, in their solutions, addressed the use of the framework to identify design problems, analyse the design context, and synthesize a general solution. Moreover, in the cases of the discipline of the Master's course, an account of the reviews is given so as to observe the way in which the architects behaved while applying the theoretical framework in their individual design processes.

A second complaint against case study concerns the idea that that method provides a slender basis for scientific generalization since it comes about from a single case. However, unlike some quantitative experiments, case studies are generalizable to theoretical propositions rather than to populations or *"universes"*. This means that a case study neither represents a "sample" of reality nor is based on statistical generalization, but rather its goal is to expand and generalize theories by a process of analytical generalization. In this inquiry, it was a matter of the pursuit of the generalization of theoretical principles concerning the application of IT in the places the projects dealt with. Three occasions were used on which to observe the results of the activities of architects using the theoretical framework while doing a project about urban places with applied IT. Those three situations made it possible to generalize the conceptual representations of the topology of physical elements and the representations of the components of technology in the same theoretical construct, correlating them under structural principles that are able to explain the origin and evolution of places and justify IT application as a means to reinforce the essential qualities of the places concerned.

The third most frequently voiced complaint about case studies is that, while they gathering what is deemed to be the required amount of data about the observed field of study, they are of indefinite duration, with the result that the end-product is normally a massive, lengthy and unreadable document. According to Yin (2003), this prejudice comes about from the common confusion of

case studies with other specific methods of data collection such as ethnography and participant-observation. For example, ethnographical research works demand long-term collection of qualitative and quantitative evidence that result in hefty and unwieldy descriptions, whilst participant-observation is also time-consuming, since the proximity and engagement with the field observed require extended observations. Then again, case studies are a form of inquiry in which technical flexibility in gathering data is regarded as an providing it with an advantage over other methods of study, which means that, depending on the topic being studied, case studies can often, but not necessarily always, use ethnographies or participant-observer data. In addition, case study techniques permit a reduction of the related documentation by systematic referencing through questions and answers based on the content of the database, or reduction by cross-case analysis in multiple-case studies, covering purely descriptive or explanatory topics. This is the case in this inquiry, which also uses participant-observation restricted to the period of the project reviews that took place in the classroom, shortening the process and focusing precisely on the specific information to be considered. Also during the period of data analysis, the cross-referencing of the cases has eliminated the necessity for repeated descriptions, thus making the reports much more concise.

4.4.3. Functions of case study method

Now those frequently cited complaints have been addressed, it is now possible to emphasize some advantages of the choice of case study method by observing how it functions in the context of this research. Firstly, the most important role it plays is that it provides efficient explanations when presumed causal links between phenomena and real-life situations that are normally too complex for the lens of surveys or experimental strategies are required. In other words, the characteristics of the developed theoretical framework are expressed exactly by the links between the observed phenomenon and the real situations. Or to put it another way, it provides links between the framework as a means of representing the correlations between place and IT and the skills given to the architects by the framework in order to analyse the design context and design a solution. As was mentioned earlier in the section 4.3, this situation of interweaved contexts was considered to be a very complex one since detachment from a contextual background was not deemed, meaning, therefore, that all the particularities of the group of architects, their personal expressions and collective agreements should be included.

Secondly, case studies can describe both the phenomenon and the real-life context in which it occurred. This is particularly useful when it comes to retracing the correlations between the aforementioned skills of the architects (analyses, synthesis, and evaluation) and the conceptual elements of the framework. It has been pointed out that the registered observations concerning the architects' teams should be viewed as analytically complementary to the analysis of the resultant projects, and what all those situations had in common was the need to clarify the characteristics of the theoretical approach so as to enable language to represent and communicate ideas about the use of IT in places. The fact that those analyses can be done with the same descriptive tool assures those complementarities.

A third function is the fact that the case study method is descriptively helpful in the illustration of certain topics within an evaluation. For instance, in the context of this research, such a function aided the description of the refinements made to the framework, between its applications by the architects and the respective analysis of the results.

Fourth, the case study strategy can be used to explore those situations in which the phenomenon that is being evaluated has no clear, single set of outcomes. For the cases involved in this inquiry,

the projects developed by the architects were evaluated as an expression of educational outcomes, concerning the skills related to understanding, as was mentioned in section 4.2.2.

Finally, the case study can be used as a 'meta-evaluation' process, which means that it can be applied when evaluating the validity of another study that requires a more complex form of data collection. The fact that multiple-case studies were chosen in this research suggested that the replication of the circumstances of the cases could act as a refining resource for new observations in future research works. The two applications, in 2006 and 2007, in the module of the Master's course were regarded as a replication of the delimitations of this research.

4.4.4. Types of case study

Five types of case studies are mentioned by Yin (2003), on the basis of the relationships that exist between the observed phenomenon and its context: *critical cases, unique or extreme cases, representative cases, revelatory cases* and *longitudinal cases*. The closest possible analysis will permit understanding of such classifications according to their characteristics, allowing for the clarification of which types have the best characteristics for this inquiry.

With regard to the observed phenomenon, *single case studies* can test a theory being critical relative to the hypothesis in the case, confirming, challenging or extending them. More than one theory can be also tested by comparison, determining which theory's propositions are better at explaining the phenomenon. The *single case study* in this sense can represent a significant contribution to knowledge and theory building, and can even help to refocus future investigations in an entire field. In this research, a place-theoretical framework to design the use of IT was firstly developed to be tested later on by architects, during the module of the master course (see Chapter 6 and Chapter 7). In this situation, the observed phenomenon was the application of that framework by the architects in a project concerned with urban areas. Each application contributed to the observation of how the framework assisted the architects on a theoretical level by analysing the resultant projects and the justifications given for the various design solutions. It was assumed, at first, that the architects would easily make appropriate correlations between identified spatial conflicts and the potential use of IT to provide solutions. However, it was observed that those correlations did not happen (see section 6.4 on page 136). Thus, the theoretical framework was refined by close scrutiny of the topology of the place's elements and the correlation of that topology with each category of generic IT component, such as sensors, servomechanism, and displays, classified in terms of their function (elements that sense, actuate and represent the place. See section 6.5 below, on page 140.). The refinement, improvement and expansion of the theoretical framework are regarded as a consequence of the critical function provided by the case study analysis.

Focusing on the observed phenomenon, when the phenomenon is rare, case studies are useful in testing *extreme or unique cases*, permitting them to cope with the rarity of the phenomena concerned, as it happens to be the case, for instance, in the study of some very rare diseases in clinical research.

But with regard to commonly observed phenomenon, *single-case studies* can be suitable for studying representative or typical situations where it is important to capture the circumstances and conditions of everyday or commonplace events. In this category, *single-case studies* are informative about the learned experiences of the average person and even institutions, for example, a urban community, its institutions and representatives. The present inquiry has recognised this latter ability of case studies in order to focus on the team of architects, who, when designing an urban project, had integrated what has been considered a typical situation so as to analyse the use

of some kind of framework. It means that the team of architects were considered representative of the professionals who were the target users of the framework to be developed by this research.

With regard to the context that forms the background to the phenomenon concerned, when the circumstances that it happens under are *rare*, cases studies can be revelatory. This means that, when regarding to phenomena that rarely present opportunities for observation, a *single study* can reveal unexpected facts. An example of this is the observation of the level of sunlight in the sky of the United States over the course of the 3 days following the terrorist attacks of September 11th 2001. As it was decided that air-traffic over that country should be suspended over the course of that period, a corresponding reduction of smog was observed and it was possible to relate this to the case study concerned with the "*Global Dimming Theory*" (Placing 1997). The same event presented an opportunity for other case studies. In the case of economics, for example, it could be used to observe a phenomenon like passengers' flying preferences (Webber 2006). The important point to stress here is that this situation is cited as an exemplar to illustrate how some rare situations can reveal information that might otherwise remain undetected.

Finally, regarding the context of a phenomenon and its changes over time, the *single case study* is able to represent a "*longitudinal*" case by studying a single case at two or more different points in time. The theory focused would likely specify how certain conditions change over time, and the selected time intervals would reflect the stages at which anticipated changes would be likely to reveal themselves.

By way of concluding this analysis of case study types and the context of this research, it is possible to say that two types of function have been found to be most suitable for the purposes of this research. First is the way that case studies can be used for testing a theory, and second, their strategy for analysing a representative situation where theories can be useful in supporting design. However, in order to make sure that the characteristics of the theory were both observed in representative and similar situations and regarded critically, more than one application of the framework was required in the Master's course module. This led directly to the definition of the *multiple-case study*, which it is now in order to elucidate.

4.4.5. The replications

The same study may contain more than one case, thus bringing about a *multiple-case study* which has the effect of increasing the overall strength of the study, since *multiple-case studies* are often considered more compelling (Herriott and Firestone 1983). However, the conduct of a *multiple-case study* can require the expenditure of resources and time beyond the means of a single research investigator. Yin (2003) has advised that all those characteristics should be assessed according to the design of the research, with due consideration being paid to the appropriateness of the multiple or single case approach.

In the *multiple-case study*, a set of situations replicates the phenomenon under different conditions, once again, with the aim of generalizing the findings to theoretical propositions. This process of replication allows us to analyse whether the phenomenon will preserve its results under the same circumstances and it will confirm or reject that theory as a steady and acceptable explication for that particular context. But it also permits observation of how the new circumstances are being related to changes in the results of the experiment, thus eliciting theoretical improvements. These refinements are the elimination of hypotheses that have been denied confirmation by the study and the nourishment of future cases with new hypotheses. Replication, therefore, is concerned with theoretical re-structuring.

Yin (2003) points out that, according to the purpose of the *multiple-case study*, the replication can be *literal*, or *theoretical*. *Literal replication* corresponds to *multiple-case studies* where the cases are a replica of the structure of the phenomenon in focus which is now observed under different contexts in order to confirm or refute predicted results. That means, *literal replication* aims to confirm theories or specific hypotheses. Despite being similar to the traditional concept of experiment, it aims to generalize the findings to sustain a theory or hypothesis, confirming or denying that theory, whereas experiments can be only considered with statistical generalizations to provide a quantitative basis for the phenomenon.

Theoretical replication is the strategy for contrasting the results of the replicated cases. By observing the differences in the results caused by controlled changes in the context, this strategy aims to widen the theoretical framework by "*feed-backing*" it with improved explications based on the new findings. Thus, the amendments of the theoretical framework will be tested again in new replicas of the case. Once again, the purpose of the replication is different from the sampling logic of experiments, and it aims to get generalizations to *"feed"* the theoretical framework.

For this research, the strategy of replication was, simultaneously, *literal* and *theoretical*. It was predominantly *theoretical*, since what was planned was to observe, through the two replications in the class of Master's students, how the framework would help architects in the creation of places with Ubiquitous Computing. The framework was improved after its first application in the class of 2006, and another application in the same course followed the next year. Thus, the second situation may be considered a replica of the context of the first case, thus allowing for the observation of how the changes in the theory affected the projects' results.

On the other hand, regarding the three occasions considered as cases in this research, when IT was applied in order to reinforce the place's qualities, it was possible to observe how those three different urban places (a commercial street in South Korea in 2005, a commercial street and a university campus concourse space in United Kingdom, 2006 and 2007 respectively) were transformed by solutions provided under the auspices of the same evolutional theoretical structure. In other words, the replication was regarded as a *literal replication*. Those different places, their characteristics, complexities and cultural backgrounds can be considered as the different contexts within which the effect of a theory about the application of Ubiquitous Systems on all of those things was observed. Thus, it permitted the characterization of the skills of the architects in describing the design context (using the framework concepts), in analysing it (again, using the framework), and in prescribing solutions to the problems detected. Those skills were analysed in light of how much they were enabled by the knowledge of the structured set of concepts of the framework. This analysis was revealing of the characteristics of the framework itself, clarifying how the concepts acted as representations of the correlations between spatial elements that constitute place and the elements of generic Information Technology. This latter strategy must be elucidated in the next section in order to analyse other peculiarities of the research method.

4.4.6. Unity of analysis for this research

In social sciences, for a research that uses case study method, the fundamental problem that defines the concept of *unity of analysis* is the definition of what the case is. *Unity of analysis* focuses on primary delimitations of the phenomenon and of the *"universe"* of representative data, mainly by providing correct analytical filters (Hessler 1992; Yin 2003). This concern seems to be pretty clear for research projects that deal with individuals or institutions, but in terms of architectural subjects some adaptations are required.

If a case study is addressing attention to the development of a theory, as is the case with this research, that theory should be considered the primary unit of analysis. However, research propositions would be needed to help identify relevant information about that theory. Those propositions would avoid the need for covering an endless amount of sources related to that method and it would define the feasible limits of data collection. The limitations introduced by the establishment of a unity of analysis are an effective lens through which where to collect valid data and how it is related to the observed phenomenon may be more clearly seen.

As with many other characteristics of research, *unity of analysis* is related to the definition of the initial key questions. According to Yin (2003), the selection of the appropriate *unit of analysis* occurs when the primary research questions are accurately specified. This means that their formulation should favour one *unity of analysis* over another, thus elucidating the objective phenomenon to be observed. Because defining *unity of analysis* is very difficult, some conceptual flexibility should be observed in order to permit analytical reconsiderations and realignments during the research, so that the occurrence of unexpected findings can be also considered and analysed when necessary.

It has been said that, for this research at least, *the theoretical framework to design Ubicomp in urban spaces* is regarded as the unity of analysis. It has also been suggested that that framework is the observed phenomenon (see section 4.3 on page 84). The question now is to investigate the ways through which that phenomenon can be observed in order to collect valid and meaningful data. Before that, however, it will be useful to return to the key questions, in order to unpack them in terms of propositions that can help the delimitation of the *"universe"* of data collection, thus permitting a sequential clarification of the analytical principles adopted to link those data to the propositions themselves.

It has been predicted that the application of an appropriate theoretical framework is able support the design of Ubicomp Systems in urban spaces and improve and reinforce the place's essential qualities. It has also been expected that the circumstances of application of such a theory would enable the observation of some theoretical correlations between spatial elements of the urban place, activities lodged in it and the information flux. The validity of such correlations will reside in the degree of effectiveness with which architects were enabled to describe, foresee, and prescribe situations resulting from the design solutions during the project. In other words, correlations between place, information, and technology would not be characterized through historical and descriptive investigations of built places where IT was applied, but, rather, how effectively those correlations can provide justifications for the application of IT in the project. The research deals with an investigation of tools that enable the design of the use of IT to be supported, and it does not deduce that tool from investigating correlations between theoretical propositions and built solutions based on it. This is so because it is concerned with the means to theoretically represent reality based on both the points of view of Architecture and Information Technology, thus establishing a communal vocabulary describing the manipulation of elements in both fields. As the means of that manipulation is the architectural project - the blueprint with its graphical representations, rationales and associated comments – then, consequently, the project becomes the primary *analytical unit* of this research. Attention has also been given to the behaviour of the architects while they were using the framework in the pursuit of design solutions during review sessions. Then, in view of what has already been said, a flexible approach to the selection of relevant data was determined, delimiting the *"universe"* in order to acquire them in both the project and its review sessions.

Three points logically emerge from these latter considerations. Firstly, it is necessary to observe how the theory organizes knowledge about the elements of place and about IT in a structured and coherent approach, clear enough to be understood in the language that architects use. This means that it is necessary to observe how the framework can offer a theoretical approach regarding the correlations between IT and the elements of place. Chapter 2 entitled "Development of a

framework" discussed this point, describing the framework, and characterizing its evolution. Secondly, it is necessary to observe how those theoretical aspects have been used by the architects to support their design decisions. This leads to Chapter 5, Chapter 6 and Chapter 7, describing the Cases, and to the Chapter 8, Discussion and Evaluation, concerned with those cases. However, before taking those aforementioned steps, a third point concerns the kind of logic that has been used to link the data collected to the propositions of the research. That means that, while discussing the methodology, it will be necessary to justify the adopted criteria in order to analyse the data extracted from the resulting projects and from the observations of the architects' behaviour, characterizing the logic used to observe them. This is the subject matter of the following section.

4.5. Criteria to interpret data

Section 4.2.2 on page 81 mentioned that the pedagogical model of Benjamin Bloom (1956) has been used as a means of assuring the internal validity of the research design. Now, that model will be examined more deeply to clarify how it has permitted the evaluation of the data collected through the work resulting from the architects' projects, and how educational objectives and enunciations that derived from Bloom's taxonomy have guided the interpretation of the performance of the architects in their projects.

As will be recalled from the discussion in previous sections, so far the justification for this research has been given in terms of the development of a theoretical framework to help architects in the design of the use of IT in urban spaces. Consequently, the observed phenomenon is the framework itself, regarded as a theoretical support. That framework is supposed to help architects specifically in the establishment of correlations between elements of IT and elements of place, through a topology that reinforces the qualities of the places. To observe those correlations from a valid point of view, an initial theoretical development, resulting from the Gwangbok Street project, was refined by means of two cases. Those cases were a replication of the initial project context and they concerned a module of the Master's course in the University of Sheffield that was taught in 2006 and 2007. Those replications have allowed improvements in the framework to be made by observing architects and the resulting projects.

Therefore, the observation of architects while they were using the framework in that discipline and the observation of the resulting drawings and writings were considered the means of studying the characteristics of the framework. That procedure was a way of observing how efficient (or otherwise) some established correlations between IT and place had been in providing coherent justification for the use of IT. Thus, resulting projects – drawings and rationales – were considered to constitute the *unity of analysis* for this research. Now, the problem is describing valid criteria to interpret those projects so as to permit the evaluation of how much the framework has influenced the results and how much it was really useful in the handling of the process of design. By what criteria could the drawings and texts produced by the architects be observed so as to reveal the efficiency and further characteristics of the framework? How would such graphical material permit the study of the aforementioned correlations regarding their effectiveness in representing the use of Ubicomp Systems in public areas? These latter considerations raise some questions concerning the nature of the theoretical framework developed and require a broad methodological discussion. It is worthwhile discussing this issue now in order to achieve a coherent understanding of the criteria adopted hereafter.

4.5.1. Representations and their problem

The framework developed here is a theoretical construct that aims, within some limits, to represent reality, thus enabling architects to describe, explain, and recommend future modifications inside those limits. Furthermore, it could be said that the framework has been conceived so as to represent the design of an urban intervention where IT ought to be used as solution to reinforce qualities of place. In other words, the goal of such representation is to permit the management of knowledge about the elements of the place and the elements of IT, in a correlative manner, explaining how they can be potentially associated with each other so as to reinforce the qualities of an urban area concerned with territoriality, privacy, identity and ambience. This system of representations should help architects produce inferences while reasoning about the use of digital technologies components in the places. It should also provide justifications for the use of IT as part of an efficient Ubicomp System.

In representing knowledge about correlations between IT and place, the framework, therefore, at bottom offers theoretical surrogates for reality itself. Those theoretical elements are supposed to enable architects to represent the context of the project, facilitating their communication with other professionals and allowing them to predict results by thinking and planning rather than building or manufacturing the solutions. Then, the question that follows is about whether that representation of reality can be regarded as an effective resource for guiding subsequent actions in the achievement of planned solutions or not. So, how to tell whether the developed framework is an efficient representation of the reality of the case when it comes to guiding architects towards making important design decisions? The analysis of the data collected would also demand another way of dealing with representations: since the projects and texts produced by architects are being considered the *unit of analysis*, how should that material be taken to represent the efficiency of the applied framework? All Those previous questions can be regarded as part of the discussion about representations and the problems they raise in this study. A brief account would clarify these points.

Theoretical constructs, as representations, involve a general problem in that they lack complexity relative to the actual situations that the theory tries to represent. In other words, representations of reality incur oversimplification, resulting the elimination of aspects considered irrelevant and preserving aspects considered important. However, "*irrelevant*" and "*important*" are notions that are much more closely connected to ideological factors and assumptions than to scientific criteria. Therefore, in order to understand what this means and implies, a brief account of the definition of ideology should be given.

Ideology is any system of ideas that represents reality. Its organization aims to offer a normative thought process to guide actions in society. For the purposes of this research, the adopted concept of ideology corresponds to that developed by the French philosopher *Louis Pierre Althusser* whose understandings of ideology is connected with the process of communication.

In a broad sense, Althusser contributed to the critique of Marxism by means of his reasoning concerning language. This became known as '*Structuralist Marxism*', and unlike the Marxism of Marx, it saw ideology as having been generated by language rather than the social division of labour as claimed by Marx. Thus, according to Althusser (1971), the human brain's access to reality is initially established by complex processes of recognition relying on language. At the same time, the invention of language was the initial moment by which ideology was introduced into human activities. Gradually, however, it has taken over the role of human lived experience in the meaningful articulation between everything and with everything by using the experience of the symbolization of that original articulation expressed by the logically structured language as a substitute. Thus, language is the means through which the human social milieu is coherently

described, explained and justified, concealing the gaps and flaws caused by the reduction of the multidimensional aspects of the lived experience to the one-dimensional linearity of language.

Thus, according to the approach of Althusser, distortions in communication are, implicitly, part of the process of communicating. Therefore, if a framework is considered as an organized means to inform actions, the way in which a framework selects some elements and discards others, representing a reality is only comprehensible in terms of the consideration of the distortion process that ideology brings. In other words, those distortions are only visible when research investigators, scientists and their practices are considered in light of a wider perspective - through a lens that can focus on their engagement in the social milieu, on their commitments and on their preferences within their vast web of relations with people, objects and technology (Latour 1987).

Notions of relevancy - i.e. what should be eliminated or maintained in a theoretical model - will interfere over the features of what the model represents, when it is supposed to be used as a theory to explain reality and as a guide to action. But the simplifications resulting from the removal of considered excessive aspects are distortions of reality, and when they occur they can limit the framework by reducing the extent to which the framework could explain a studied phenomenon. Thus, it could be said that the efficiency of theoretical representations is limited by the ideological set that underpins the reality that they represent to a social milieu. As such, examining this problem, since it lies at the heart of this research, will make for a more precise account of the limits of the developed framework.

As was mentioned earlier, the central problem of the ideology of representations can be systematically studied through the analysis of the social nature of the scientific practices of research investigators and scientists. However, the idea can also be used to focus on the architects' works and their representational practices, since they use a wide range of representations in their works, from correspondences through theories, blueprints and drawings. The representational practices of the architects can even be broadened to include ideas and schemes of the "*universe*" inhabited by the users affected by the design solutions and by representations of adopted technologies. Indeed, all those references to representations stress the need for a clarification of that term when it is used to refer to models that represent arrangements of society and technology. Some social studies disciplines can be of help at this juncture, and, therefore, it is valid to discuss the term "*representation*" in those studies and how this is reflected in the field of Architecture.

Social studies concerned with science are devoted mainly to research on the concepts, processes, development, mediations and consequences of modern Science and Technology, focusing on the analysis of their social nature (Woolgar 1988). That discipline covers a diverse range of topics, and encompasses a variety of disciplinary interests, notably sociology and the history of science, and less prominently philosophy, anthropology and psychology. The main claim of that discipline is that science is socially constructed and it is not determined by the world or some physical reality out of the social milieu. Reality, from this point of view, cannot be used to explain why a statement becomes a fact, since it is only after a fact has been constructed that the effect of reality is obtained. Ian Mitroff (1974), Steve Woolgar and Bruno Latour (1979) could be mentioned as examples of those who take this *constructionist view*, the latter having introduced his views on the social construction of objectivity in his original "*actor network theory*", which was mentioned in the Chapter 1.

Therefore, on the basis of the aforementioned studies, which aim their analyses at the social nature of representation, it will be argued that representation is the means by which images (reflections, representations, reports) of an object "*out there*" are generated. Representation is axiomatic to all activities that claim to capture some feature beyond the phenomenon itself. According to Woolgar (1988), discussions in and about science are characterized by their reliance on such fundamental dualism – the supposed distinction between "*representation*" and "*object*". To exemplify the

pervasiveness of the notion of that dualism in Sciences and Social Sciences, Woolgar uses a table, which was adapted as follows:

Representation	Object
Image	Reality
Document	Underlying pattern
Action or Behaviour	Intention
Knowledge	Facts
Voltmeter reading	Voltage
Documentary evidence	The historical situation
Questionnaire response	Respondent's attitude
Explanandum	Explanans
Project Drawings	Resultant built places
Enclosure of place	Walls and floor extensions
Centrality of place	A monument in a square
Drawings and texts (project and its rationale)	Knowledge to design Ubicomp systems (framework efficiency)

Table 20: Couples of representation and its object, adapted from Woolgar (1988).

The problem of those dualities raises the following question: how can we be sure that the representation is indeed a proper, true reflection of the object? This question is linked to a problem of methodological adequacy, which is very important to the development of the theoretical framework that has been pursued by this research, and is aiming to characterize the grounds which are supposed to provide the warrant for the relationship between the objects of study and the statements that were made about those objects.

For this inquiry, that problem could be categorized by two different instances. In the first instance, there are representational problems intrinsically related to the framework itself, corresponding to reductions caused by the theoretical model adopted to explain the concept of place. In the other instance, there are problems related to the interpretation of the data collected in the project representing the features of the framework, its effectiveness and limitations.

In the first instance the following question could be posed: "*how effectively does the proposed framework represent the place and the digital technologies components?*" On the theoretical level, it is reasonable to consider that some distortions were occasioned by the composition of a theoretical model of place. For instance, according to the adopted model, four qualities should be considered to be the main qualities of place: territoriality, privacy, identity and ambience. Those qualities, as discussed in the Chapter 2 are derived from the spatialization of the social phenomena. That social phenomenon is geometrically referenced and spatially located according to the perspective of *Martin Heidegger (1962; 1969;1975)* from whose theory this research borrows, among others, the concepts of "*being-in-the-world*" and "*dwelling*" in order to account for place as *qualified space*. The use of digital technologies components is supposed to reinforce those qualities when Ubicomp Systems are designed specifically for the places in question. However, it could be argued that other particularities of places should be considered for adoption as theoretical models. For instance, that model could consider other theoretical approaches that ignore the spatial bias previously mentioned and regard exclusively aspects like "*history*" and "*individuals' behaviour*" to define place spatially, as is the case, for instance, in the view of *Michel Foucault* (2004). However, the decision to adopt the present theoretical model of place results from the intention to address the framework mainly to architects, bearing in mind the characteristics of their job. The aforementioned ideological distortions, thus, result from the intention of making the framework

thoroughly intelligible to architects, thereby facilitating their handling of the concepts in the course of their professional activities.

A second instance corresponds to problems caused by representations when the resulting projects are regarded as representing the framework's efficiency. The question that summarizes this concern is: *how fair is it to consider the resulting projects as representations of the framework's effectiveness?* Since the projects of the architects are taken to be the unit of analysis in this research, those projects assemble representations of elements of place and IT with the aim of expressing design solutions. Together, with the rationales, those projects reflect the extent to which the framework facilitates the conceptual manipulation of elements to construct and to justify solutions. Thus it permits us to observe how the architects can afford to establish correlations between components of place and elements of IT, justifying those correlations in terms of the strengthening of the local qualities of territoriality, privacy, identity and ambience.

As representations, the projects possibly have a distorted correspondence with reality - in other words with the framework concepts - when the latter is regarded as an assessable representation to measure framework effectiveness. Such a distortion can be caused by the required learning process necessary to provide the architects with knowledge about how to use the framework. Thus, missing points occasioned by lack of information, the absence of architects from the discussions and other problematic factors could reduce the correct degree of equivalence between the framework knowledge and its representation i.e. the project. In other words, architects could have misused the framework's concepts simply because they were missing information. With that distortion, the projects could be regarded only as a means of efficiently assessing the learning process, not the framework itself. The adopted strategy to avoid this situation was to demand that the architects organize themselves in working groups to tackle the project's activities. This provided a way of covering missing information as consequence of the learning processes, ensuring that the whole team had a full overview of the theory. Therefore, the projects resulting could be considered as a reflection of the knowledge of the framework itself.

This discussion drives towards the conclusion that is reasonable to consider that the project itself can represent the knowledge that is acquired by understanding the framework. The result of the application of the framework is the project and, regarded as outcomes, they could be compared with results that are hypothetically expected when one is using the framework. Therefore, it seems both appropriate and reasonable to enunciate the outcomes expected in the resulting projects and to investigate and assess those outcomes in terms of their characteristics as knowledge in order to find about the framework effectiveness. The next section deals with this idea, focusing on a method of classifying the characteristics of the knowledge provided by the framework as educational objectives, or in other words, to classify the understanding of the architects.

4.5.2. Taxonomy of the understanding

It was remarked in section 4.2.1 that a theory which has addressed the assessment of educational outcomes was used as a means of analysing the resulting projects and rationales in this research. The next sections will address to the implications of that theory by giving a thorough account. Firstly, the historical development of the educational taxonomy will be commented on, followed by an introduction of its general characteristics. Secondly, both the way it functions and the way of using it in order to specify educational outcomes will be examined. At a deeper level, characteristics specifically connected with this research will be explained, together with the justifications of the use of it. A final characterization of its use in the analysis of the projects will be introduced, followed by the description of the main outcomes formulated.

Educators and psychologists concerned with theories of learning have made considerable contributions to the study of the various types of learning that take place in schools. Probably the most comprehensive and widely known analysis of objectives was given by the educational psychologist Benjamin S. Bloom. In 1949, he had conceived, in conjunction with other specialists from across the United States, a framework for classifying statements of what students are expected to learn as a result of instruction. His taxonomy aimed to provide a consistent means of developing what is considered by some authors (Arreola and Aleamoni 1998; Anderson *et al.* 2001) the single most powerful tool in instruction and the assessment of student learning outcomes: the learning objective or performance objective. In 1956, after regularly meeting with that group to develop and make revisions in the framework, they published their first draft under the title *"Taxonomy of Educational Objectives: The Classification of Educational Goals. Handbook I: Cognitive Domain"* (Bloom 1956).

At the time of its introduction, at least two strong pedagogical tendencies dominated the debate about the learning process in higher education. One of those, a traditional approach that included behaviourist ideas, regarded learning and the attainment of educational standards as a conservative process fundamentally characterized by an emphasis on the imitation of the tutor's actions and on repetition of exercises. The other tendency was influenced by the thoughts of the Swiss psychologist *Jean Piaget.* This approach to the learning process placed more emphasis on the experiences gained by the students under the strict supervision of the tutor. These could be seen as *"experiments"* that had predicted results that were known by the tutor. And as such he was in charge of the design of a set of strategic experiments which were supposed to guide the process of the construction of the students' knowledge through that controlled contact with reality. Those two pedagogical tendencies were criticized at that time in the light of ideological views that claimed that they were promoting a learning process that was without creativity and resulting in conformism. Changes in the pedagogy were supposed to be merely a reflection of the industrial development achieved by the United States and the claims to supremacy in the progress of all fields. Thus, by its nature, Bloom's taxonomy found fertile terrain in schools all over the country, since it presented a clear way of organizing levels of understanding, facilitating assessment, thus speeding the learning process and metaphorically following the same trajectory as the increase in industrial efficiency. In the 1950's, the term "*taxonomy*" was unfamiliar as an education term but after the spread of Bloom's taxonomy, it became widely known and cited, and the work was eventually translated into 22 languages. The revision of that framework was developed 45 years later into a revised Taxonomy (Anderson, Krathwohl *et al.* 2001), adding complexity to emphasize the teaching process.

Originally Bloom's vision of pedagogy relied on the acceptance of three different domains mobilized in the learning process. The first concerns cognition, involving knowledge and the development of intellectual skills. This includes the recall or recognition of specific facts, procedural patterns, and concepts that serve in the development of intellectual abilities and skills. The second is the *affective* or *volitive domain*, which includes the manner in which the learner deals emotionally with the learning process. *Volitive domain* includes the values, appreciation, enthusiasms, motivations, attitudes and commitments that are related to the learning. Finally, the third domain is the *psychomotor domain*, which includes all learning related to the manipulation of instruments and tools. It focuses on corporeal learning, regarding physical movement, coordination and use of the motor-skill areas; in other words it is concerned with the use of the body.

Each domain was supposed to be equipped with internal categories classifying the learning outcomes but, originally, the taxonomy provided only developed definitions for cognition. Objectives for the cognitive domains were thus usually framed in terms of some subject matter content and a description of what is to be done with or to that content. Thus, statements of those objectives typically consist of a noun or noun phrase, which represents the subject matter content,

and a verb or verb phrase, which represents the cognitive processes. To understand the categories of understanding according to this, the original classification of the cognitive domain was as follows:

- *Knowledge*: the ability to recall information. The activities are normally specified with verbs such as *recall, identify, recognize, acquire,* and *distinguish.*

- *Comprehension*: the ability to rearrange or rephrase knowledge. The actions are expressed by verbs such as *translate, extrapolate, convert, interpret, abstract,* and *transform.*

- *Application*: the ability to apply the rearranged or rephrased knowledge. Normally, the verbs used in actions are: *sequence, carry out, solve, prepare, operate, generalize, plan, repair,* and *explain.*

- *Analysis*: the ability to break a problem down into parts and establish relationship between each part. The verbs are: analyze, estimate, compare, observe, detect, classify, discover, discriminate, identify, explore, distinguish, catalogue, investigate, breakdown, order, recognize, and determine.

- *Synthesis*: the ability to combine relevant disparate elements. The verbs that reflect the action are: *write, plan, integrate, formulate, propose, specify, produce, organize, theorize, design, build,* and *systematize.*

- *Evaluation*: the ability to make a judgement of knowledge, analysis and synthesis. The actions are expressed by verbs such as *evaluate, verify, assess, test, judge, rank, measure, appraise, select,* and *check.*

With the exception of the category *Application*, each of these types of objectives can be broken down into subcategories, shown in Table 21. The categories are ordered from simple to complex and from concrete to abstract. Furthermore, it was assumed that the original Taxonomy represented a cumulative hierarchy; that is, mastery of each simpler category was prerequisite to mastery of the next, more complex.

In turn, the *Cognitive Process Dimension* of the revised Bloom's Taxonomy (Krathwohl 2003), like the original version, specifies six skills. They are, from the simplest to most complex:

- *Remembering*: recognizing and recalling relevant information from long-term memory.
- *Understanding*: the ability to create personal meanings from educational material such as reading and pedagogical explanations. The sub-skills for this process include interpreting, exemplifying, classifying, summarizing, inferring, comparing, and explaining.

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Structure of the Original Taxonomy

1. Knowledge

    1.1 Knowledge of specifics

        1.1.1 Knowledge of terminology
        1.1.2 Knowledge of specific facts

    1.2 Knowledge of ways and means of dealing with specifics

        1.2.1 Knowledge of conventions
        1.2.2 Knowledge of trends and sequences
        1.2.3 Knowledge of classifications and categories
        1.2.4 Knowledge of criteria
        1.2.5 Knowledge of methodology

    1.3 Knowledge of universals and abstractions in a field

        1.3.1 Knowledge of principles and generalizations
        1.3.2 Knowledge of theories and structures

2.0 Comprehension

    2.1 Translation
    2.2 Interpretation
    2.3 Extrapolation

3.0 Application

4.0 Analysis

    4.1 Analysis of elements
    4.2 Analysis of relationships
    4.3 Analysis of organizational principles

5.0 Synthesis

    5.1 Production of a unique communication
    5.2 Production of a plan, or proposed set of operations
    5.3 Derivation of a set of abstract relations

6.0 Evaluation

    6.1 Evaluation in terms of internal evidence
    6.2 Judgments in terms of external criteria
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Table 21: Original Bloom's taxonomy, extracted from Krathwohl (2003).

- *Applying*: using a learned procedure either in a familiar or new situation.

- *Analysis*: breaking knowledge down into parts and thinking about how the parts relate to overall structure. Students analyze by differentiating, organizing, and attributing.

- *Evaluation:* includes checking and critiquing. This occupies the top of the original taxonomy, but is listed fifth in the six processes in the revised version.

- *Creating*: this skill involves putting things together to make something new; to accomplish creative tasks, learners generate, plan, and produce. This is a process that is not included in the earlier taxonomy, but is given the highest status in the new version.

Once the possibilities and limitations of Bloom's Taxonomy were studied, it will be possible to use it as a guide to the creation of expected outcomes. Also considering the availability of the reviewed taxonomy, it will be possible to get more consistency into the analysis of the formulated learning outcomes. However, a last reflection should be done to clarify the way the key questions are related to those outcomes.

It has been seen that the projects resulting from the application of the framework in the course module could be evaluated by the criteria specified by the taxonomy in order to reflect the architects understanding of the framework itself. This means that, to observe how the framework can be effectively helpful to architect students, the resulting project should be regarded in a way that reveals the framework's effectiveness by some kind of representation. For instance, the comparison of actual results with expected results. This is the main discussion in the next section.

4.5.3. Expected results in terms of educational outcomes

As can be inferred from the reasoning just outlined, expected outcomes could be derived by the very enunciation of the key research questions, or, in other words, by changing those key questions statements into relative statements of expected educational outcomes. To do this, it is necessary to link every key question to a hypothetical context through which some expected outcomes can be stated so that they can be observed in the projects.
Table 22 exemplify this derivation.

An example of this derivation process could be given, for instance, in the first key question, which is about the kind of theoretical approach that could be developed to support the design Ubicomp in urban spaces. The "*hypothetical*" attached to that answer is that the approach will be a theory in which there is the possibility of establishing correlations between the topology of the elements of place and the components of IT - in a given situation of project. Thus, what is expected is that architects reflect on their project as their understanding constitutes knowledge about place and its correlations with the digital technologies components according to the framework developed. To observe this knowledge, it would be necessary to analyse drawings and rationales, seeking evidence that shows what the architects were able to:

Key questions	**Hypotheses related to the key questions, to be tested by the case study**	**Related education outcome expected to be observed by analysing the project**
Which ***kind of theoretical approach*** could be	It is possible to establish ***correlations***	Remembering and understanding the place: Architectural attributes

developed in order to support the application of IT resources in the design of public places?	***between the topology of the elements of place and components of IT*** to reinforce the qualities of territoriality, privacy, identity and ambience of places by communications	(dwelling), qualities of place (TPIA), Topology of the components of place (Centrality, enclosure, internal area, internal directions, entrances); conflicts identification; Remembering and understanding IT components: Types (to sense, to act, to represent the place) topology and potential interference over place's qualities (correlations between interiority/exteriority, visibility and appropriation and the functions of the IT components);
How could such theoretical approach, regarding the use of IT in urban places, ***support architects during the design process***?	A development of ***tables to analyse IT components regarding their topological correlation with the physical properties*** which originate place's qualities can help in the creation of original solutions by spatial refurbishment and by using gadgets and systems of IT.	Creating solutions: Planning the IT system together with physical interventions that will help to solve the detected conflicts;
Would be the resultant projects better and more efficient than those without any theoretical support?	The topological approach assembles together the advantage of ***providing solutions to spatial conflicts, strengthening the place's qualities by using IT*** beyond cosmetic or commercial intentions only.	***Evaluation:*** Justifying and critiquing the solutions given and evaluating them by feedbacking the theory, clearing which advantages was accomplished.

Table 22: Relations between research key questions, hypothesis and resultant expected outcomes to be observed in the projects supported by the framework of this research.

- *Remember, understand and apply architectural attributes related to the place, its elements and their topology.* This means that evidence that the architects have understanding of

basic concepts developed in the framework, such as *dwelling*, *qualities of place* (territoriality, privacy, identity and ambience) and *the topology of components of place* (centrality, enclosure, internal area, directions, entrances), should be sought in the projects. Also, the concept of conflict and skills in identifying it and analysing how it affects qualities of place, should be looked for.

- *Recognize and explain types of digital technologies components and their topology.* This means that, regarding the aim of analysing data, the projects should provide evidence that the architects understand IT in terms of components that *sense* the place, *act* on the place and *represent* the place, observing how their communications and functions could be related to topological distributions as *interiority/exteriority, visibility* and *appropriation*. Consequently, it should be observed whether they can explain how those topological relations while solving conflicts interfering on the place qualities.

- And finally *apply those types of digital technologies components by implementing interferences over the place's qualities.* This corresponds to evidence of a justifiable implementation of Ubicomp resources in the place.

In order to generate valid criteria for the interpretation of the projects resulting from the university module, an adaptation of Bloom's taxonomy is necessary. This requires listing the derived educational outcomes from the key questions in the previous table first, then obtaining the following general enunciations of outcomes that will serve as criteria:

After studying the framework developed in this research, the architects should be able to:

1. Explain the qualities of place in terms of Territoriality, Privacy, Identity and Ambience.

2. Explain the topology of the elements of place in terms of centrality, enclosure, internal area, internal directions, and entrances.

3. Given a place, identify the conflicts between spatial elements and activities and elicit how they interfere over the qualities of place.

4. Compare types of digital technologies components (to sense, act, and represent the place).

5. Explain the topology of digital technologies components and potential interference of it over place's qualities (explain the correlations between interiority/exteriority, visibility and appropriation and the functions of the digital technologies components).

The expression of the knowledge of architects about these topics constitutes the means of observing their outcomes related to the Conceptual Knowledge domain, which corresponds to a range of cognitive processes observable in the graphical material produced, from drawings to texts. Also, through those materials, as well as other expressions, can be seen as the Procedural Knowledge, which includes being able to:

6. Create solutions to the identified conflicts by using digital technologies components and spatial elements.

7. Implement the IT solutions as integrated part of place's topology.

8. Justify the use of each IT component in terms of their contributions to the solutions of conflicts, eliciting their influence over topological characteristics as interiority/exteriority, visibility and appropriation.

9. Plan the IT system together with physical interventions that will help to solve the detected conflicts.

10. Plan physical changes to support the IT system planned.

11. Specify the spatial requirements for the IT system adopted.

12. Plan schemes of IT systems, such as gadgets to be used in the place.

13. Specify the digital technologies components and gadget functions in the system so as to permit exchanges with other fields such as computing sciences.

14. Justify the solutions adopted, clarifying the accomplished advantages.

15. Criticize the solutions designed to feedback to the theory.

By using these 15 expected outcomes it will be possible to analyse the graphical material produced in the three circumstances that constitutes the case studies in this research: Gwangbok project (2005), Fargate Street project (2006) and the Campus project (2007).

4.6. Summary

In order to study the characteristics of a theoretical approach to support the design of Ubicomp applied in urban places, three situations were analysed through the method of case studies. The first was the Gwangbok Street project, 2005, where an initial concern about the design of the use of IT in public places was introduced. The second was the Fargate Street project, in 2006, where an initial set of concepts was used as a framework to guide architects in the design of the use of IT in that street. The third was the project to augment the concourse space of the University of Sheffield campus in, 2007, where the theoretical set first applied in 2006 was refined and re-applied.

In order to observe the characteristics of such a theoretical background to support the use of Ubicomp in public places, the research was designed to observe the relations between theoretical frameworks and the resulting projects, analysing the drawings and texts produced by the architects in those three projects. To achieve valid analytical tools, the framework and the projects were considered as representations of each context, and the distortions were considered to correct that analysis. The framework was assumed to be representation of knowledge about the reality of IT and place and the projects resulting were regarded as representations of the actions that that knowledge has permitted and supported. Finally, in order to analyse the projects, they were compared with some expected outcomes derived from the initial key research questions and respective hypotheses in a multiple-case study.

Chapter 5:
Case I: Gwangbok Street

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Four projects of urban revitalization have been analysed in order to observe the framework's resources and limitations when it is used by architects for the design of public places where IT is applied. They are the Gwangbok Street project (South Korea, Busan, 2005), the Fargate Street project (United Kingdom, Sheffield, 2006) and two projects concerning the concourse space at campus of the University of Sheffield (United Kingdom, 2007). As it has been mentioned in the introduction of this thesis, the International Idea Competition on Urban Design '*Revitalization of Gwangbok Street and PIFF Plaza*' at Busan city, South Korea, 2005, aimed to recast an urban area that comprised Gwangbok Street and an area of cinemas named Piff Plaza, where the annual Korean cinema competition with its related shows and exhibitions takes place. The design contest was open to qualified architects from all over the world and it focused on the qualification of an urban space, encompassing streets, pavements, squares, urban furniture and equipment.

To support the contestants, all the documents related to the analysis of the site were delivered by internet. These included drawings, old maps, texts, photographs and accurate topographic maps of the site. The texts were concerned with information about history, city zoning and its characteristics, surveys about the behaviour of shopkeepers and pedestrians, and climatic information (see page 197).

The period taken for the architects to develop the project was approximately two months, starting in June 2005 and to be accomplished by the deadline, 31 August 2005. In order to apply for the projects, the Busan city council required four A1 formats with all graphic elements in order to enable a clear understanding of the idea, plus a rationale of a maximum of 5000 words (see page 200, Gwangbok Project Drawings).

By the end of September 2005, a judge appointed by Busan City Council chose the project winner from the 150 submissions with our project being awarded the prize of '*honourable mention*'.

5.1. The urban place

The city of Busan is located on the south-west tip of the Korean peninsula, and is South Korea's largest port city. Busan's population is approximately 3.7 million, living in 16 districts and towns.

Historically, in terms of the defence of the country, Busan occupied a strategic position in the intricate balance between land and coastal forces. Later, with the advances achieved by the economy by the 1970's, it started to play a role as a national centre and the largest port for commerce. According to the City Council information (see page 197), by 2002, Busan has emerged as an important commercial and transportation hub of world trade, handling the world's third largest distribution volume. With the aim of being '*The Marine Capital of the New Northeast Asian Era*', the area of the port, which is regarded as having become increasingly marginalized, will undergo refurbishment until 2011, being rearranged with new facilities for a diversity of fields, including culture and tourism, shipping, distribution, finance and services. This plan for regeneration includes changing the image of the city from that of a port to a centre of culture and tourism. As well as the Pusan International Film Festival (PIFF), which takes place every year, the city will continue to hold international sporting events, such as those it has held in the past, for instance, the Asian Games and matches of the FIFA World Cup in Korea/Japan in 2002, as well as other high-profile international gatherings such as the 2005 APEC (Asia-Pacific Economic Cooperation) Meeting.

Figure 21: Busan in the context of South Korea map

The street of Gwangbok and the PIFF plaza are located in the district of Jung-gu, which is considered the centre of Busan's political, economic, financial, business, information and telecommunication networks, with a total area of 2,8km^2, 54,883 residents, 44 administrative agencies, and more than 60 financial and associated facilities. The daily temporary population in today's Jung-gu District reaches approximately 1 million, 20 times higher than its permanent one. This fact alone clearly indicates that the district is the heart of the business and commercial network of the city. The district is served by a metro line and an international ferry terminal which connects with the piers of the port. Two of the most famous markets in Korea are located in the district: Jagalchi Market and Gukje International Market. To complete the picture of the importance of Jung-gu as a commercial downtown area of Busan, there are other attractions, such as the Dried Fish Market, the Sindonga Market, the Lotte-Kolon Underground Mall, the Gwanbok-Nampo-Bupyeong Commercial District and other retail establishments. In short, commercial areas in Jung-gu take up almost 52% of the entire area of the district, whilst two parks are available to the residents, a park in Mount Yongdusan and Jungang park.

Other 'touristy' attractions, such as the Busan Modern History Museum and various historical sites, integrate the cultural profile of Jung-gu. By the time of the contest, the City Council was trying to implement various resolutions to revitalize the failing economic status Jun-gu's of retail sectors,

and also trying to recover from the local stagnation suffered in the 1980s and 1990s. As part of the solution to the revitalization of the district, all its attractions are being included in an integrated project to mark Jung-gu's rebirth as a centre of culture and tourism. The project for the urban revitalization of Gwangbok Street and the PIFF plaza were part of this policy.

Gwangbok Street has been established since 1678, and its physical characteristics and the characteristics of the area around it nowadays correspond to a commercial area associated with fashion. However, by the time of the international contest, the increasing number of urban periphery areas and the relocation of the City Hal caused Gwangbok Street's economy to slow down gradually. In spite of this, connected streets offer more than 5 multiplex theatres in the area named the PIFF plaza, which since 1996 has remained a cultural attraction for the promotion of Korea's film industry. As such, the City Council affirmed that the area around Gwangbok Street would be divided into 3 zones, as is shown in Figure 22, below. Based on the shape of the street space, connections with neighbouring areas, the type of shops and the behaviours of visitors, the street was divided, as indicated by the picture into Zone A (from the old city hall to old Miwhadang), Zone B (from old Miwhadang to Gukje Market) and Zone C (PIFF Plaza).

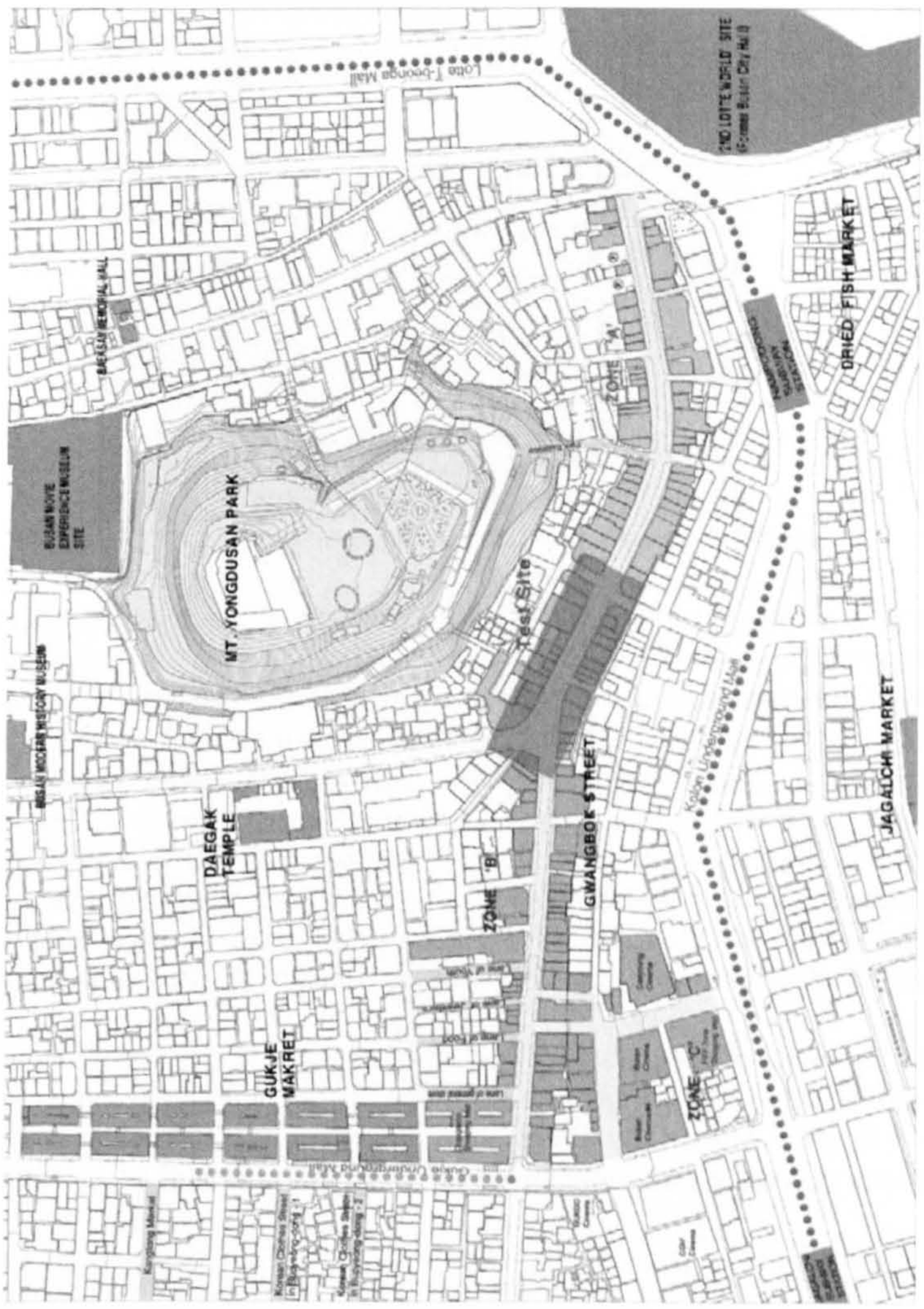


Figure 22: Zone Index Map of Gwangbok Street

Zone A is a linear street neighbouring the old city hall (Lotte World II), Yeongdo Great Bridge, the International Passenger Terminal, the Coastal Passenger Terminal and the office area in Jungang-dong. Zone A is also connected to Mt. Yongdusan Park by an escalator.

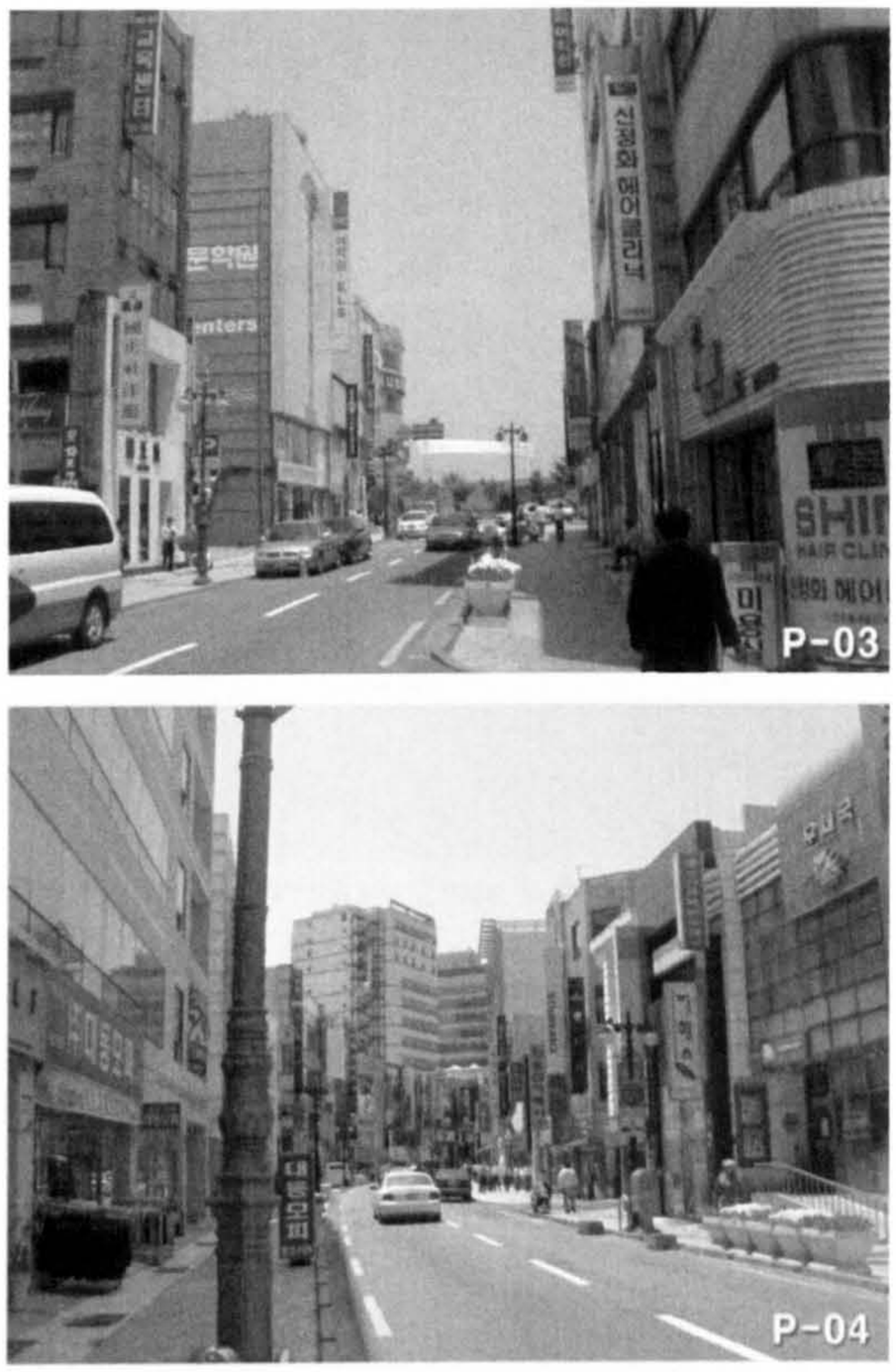


Figure 23: Beginning and end of zone A, Gwangbok Street.

According to Busan City Council, for a long time Zone A has been regarded as a street for clothing shops, and, as the table below shows, around 63% of clothing shops on Gwangbok Street are concentrated in this zone. Visitors to Zone A comfortably walk and shop on the wide street, which has a low pedestrian density; after 9 pm when the shops close, the street is empty and quiet. With its high-end brand clothing shops, wide street, low pedestrian density, comfortable shopping facilities and its image as a representative area, Zone A has a relatively high-class image. According to the respondents of the questionnaire issued by the City Council, pedestrians said that the first priority for a refurbishment should be put the eradication of illegal parking, while a few pointed to disorderly shop signs as an urgent problem. When the Lotte World II Department Store is completed, nearby shops in Zone A selling the same items are likely to be the hardest hit.

In Zone B the distribution rate of beauty parlours and cellular phone shops is 57%, and 60%, respectively, which is higher than 39%, the overall shop distribution rate to the whole street. Except for a few bakeries, most shops are relatively small and the stores on the Lane of Food and Gukje Market are mostly small-scale, too. In addition, these small shops sell relatively low-price goods.

Figure 24: Gwangbok Zone b, beginning and end.

Zone B, connecting the Lane of Food, Gukje Market and PIFF Plaza, has a high pedestrian density by both day and night. Compared to the other zones, Zone B, a kind of a bridge between the two other zones, has a relatively weak identity and image.

Figure 25: Gwangbok Street zone C, general aspects

Zone C comprises PIFF Plaza where the Busan International Film Festival has been held every October for the last 10 years. Thanks to the Film Festival, Zone C has become an internationally famous place and during the festival it has many domestic and international visitors. Many events, such as movie star hand printing, and projects such as tree planting, installation of lighting for pedestrians and pedestrian-only plaza have been completed, while there is an urgent need to

improve shop signs, building facades and street food vendors. On the questionnaire, many respondents picked Zone C as the place that was most representative of Gwangbok Street. It has a very strong identity and image compared to the other zones. Many Busan citizens use Zone C neighbouring Nampo-dong, Jagalchi Fish Market and Gukje Market. Moreover, every last Saturday of the month, on which street vendors are excluded, citizens can enjoy various cultural events. However, only 10% of respondents said that they come to Gwangbok Street to watch a movie.

5.2. Problems identified

The identification of problems in Gwangbok Street was supported by the documents delivered by Busan City Council. Those documents included surveys of shopkeepers and pedestrians and are summarized as follows:

- Around 40% of pedestrians come to the street for shopping and about 28% for meeting people;
- It was revealed that Busan citizens think of Gwangbok Street as a shopping street (39%), a 'movie' street (26%) and a street for meeting people (22%);
- For a question asking for the evaluation of the street environment, the largest respondent group, 48%, answered '*mediocre*';
- When asked about problems that damage the street landscape, the largest respondent group, 42%, pointed out illegally parked vehicles;
- For a question asking about shop signs, the biggest respondent group, 42%, said 'mediocre';
- When asked about a place that was most representative of Gwangbok Street, a majority of respondents, 64%, picked PIFF Plaza.
- When asked to recommend places worth visiting, respondents picked PIFF Plaza(22%), Youngdosan Park(18%), Jagalchi Fish Market(17%) and Gukje Market(17%) for day time and Youngdosan Park(22%), PIFF Plaza (19%) andNampo dong(16%) for night time.
- Asked about priorities for improving Gwangbok Street, respondents pointed out "the eradication of illegal parking" (46%), "rearranging disorderly shop signs" (20%) and "removing car roads and securing pedestrian paths" (7%);
- With regard to an image for Gwangbok Street to pursue in the future, 25% of respondents said a 'street of movies', 26%, a 'street of culture and art', and 18%, a 'street of shopping'.

Thus, together with the analysis of photos and maps, the architects established categories of problems affecting the four main qualities of place, territoriality, identity, privacy and ambience:

Territoriality: Two problems were considered of principal importance to the architects, both concerning the limits of areas in the precinct of the street. The first was illegal parking, which obstructs the street and the flux of pedestrians, precipitating a conflict between cars and pedestrians. The other problem was the lack of identifiable territories in front of shops, marking the transition between indoor and outdoor activities.

Privacy: the architects' text (received from Busan City Council) reports generically on activities that overlap each other and create conflict, for instance, noise or the requisition of the same resources. Those activities are mentioned by Busan City Council with regard to the open markets that exist along the street, and in the PIFF plaza area.

Ambience: the problems affecting ambience were considered to be related to the maintenance of the street elements, urban equipment and furniture. Some pictures reveal the difficulties in maintaining and cleaning sculptures, vases, benches, and other elements. Also, some materials specified were considered to interfere with the ambience, since the photos showed that they were hard to clean easily dirtied.

Identity: this was considered to be the biggest problem to be solved by design and it corresponds to the lack of particularities in the Gwangbok Street space that are able to contribute to its uniqueness as a place. This problem was considered to be a probable consequence of the emergence of internationalization of urban patterns that make no reference to the local culture, resulting from the wide variety of small private expressions in the public space. The complex system of information that exists in the place, encompassing ads, signboards etc, became chaotic, and commerce, in its effort to stay connected to external influences in the exchange of goods and services, fails to ensure that local references are reflected in the space and in the activities that take place there. This interpretation was supported by much of the evidence present in the photos and texts delivered by Busan City Council, and the conflicts affecting Identity were evidently present over the whole street.

5.3. Solutions provided

The following description of solutions was adapted from the rationale presented to the contest (see page 205), with the addition of some elements deduced from drawings that were not mentioned in that text (see page 200).

It was proposed that private motor traffic through whole street ought to be forbidden but the, the thoroughfare preserved just in case it needs to be used by cars for the purposes of supplying shops out of normal shopping hours. The pavement was redesigned using white and black dolomites, defining drawings of waves and demarking the path along the entire street, aiming to contribute of an element of visual identity to the composition.

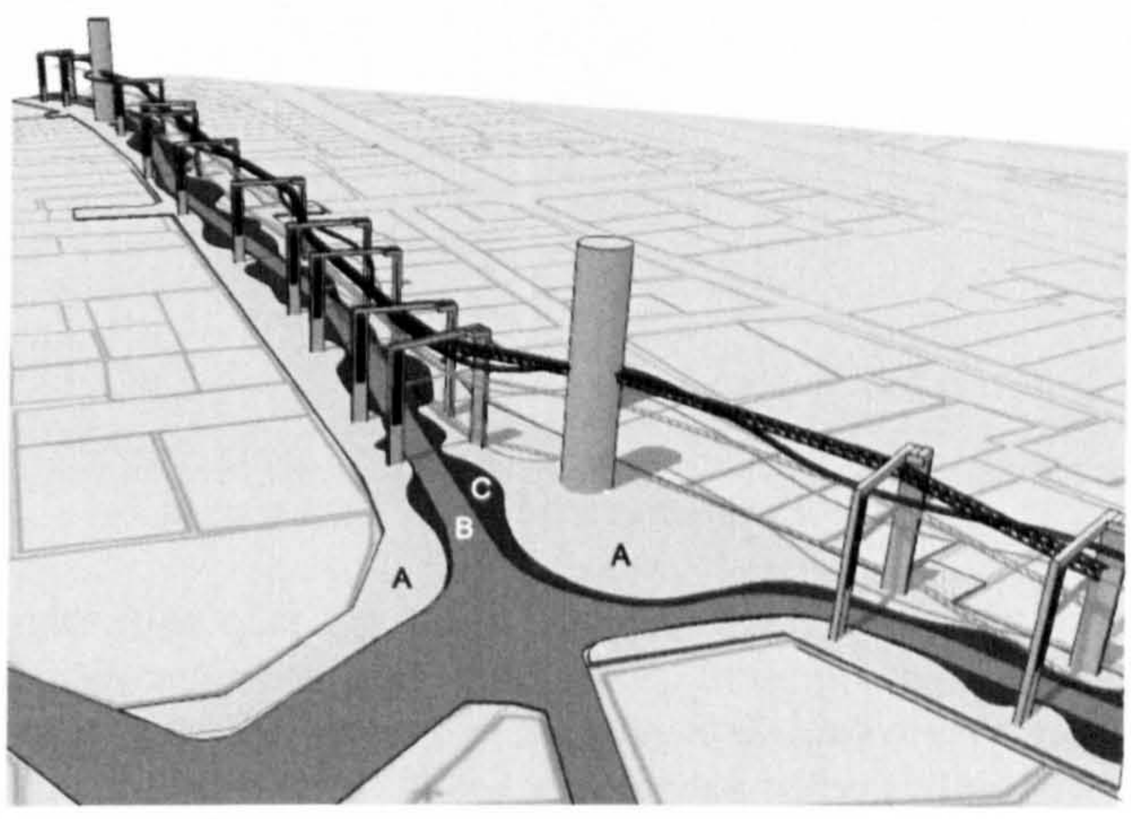
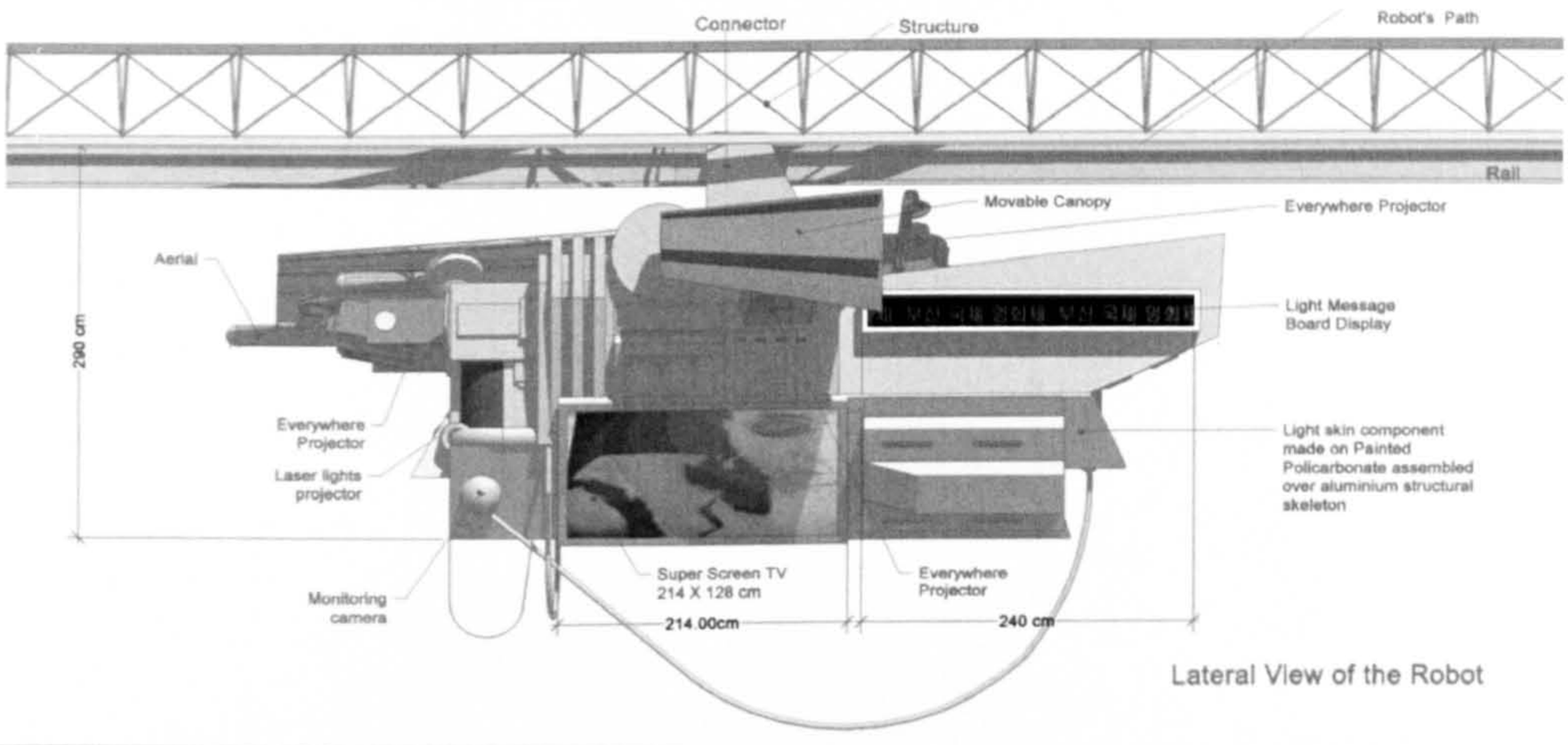
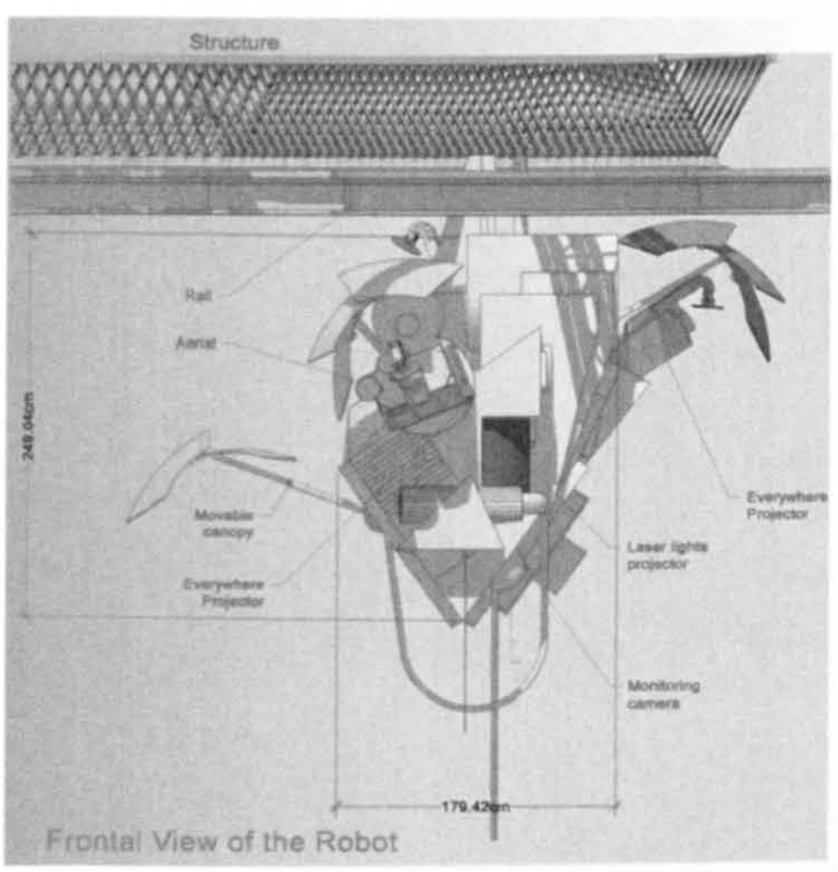


Figure 26: Scheme showing the pavement in Gwangbok: A, White Dolomite pavers; B, car traffic path; C, black dolomite pavers.

Eight movable gadgets were proposed in order to lodge digital technologies components. Each of these gadgets, termed 'Robots', included 1 Laser projector, 1 display message board, 2 big screen televisions, 2 video cameras, and 3 of '*IBM's Everywhere projectors*'.

The use of laser projectors aimed to produce special visual effects in exhibitions and parades during the night-time. The luminous message board would broadcast news about the activities in the street and thereabouts, information about local museums, events and so on. The television screen permits short clips, ads, and footage from the place, real time sequences, and other visual matter to be watched. The video cameras gather material to be mastered, afterwards being broadcast by the Robots. The '*IBM's Everywhere projector*' combines projection with detection on an arbitrary selected surface, such as a wall or a simple pavement. In effect, this coupling turns the surface into a crude wireless touch screen; the ground and walls literally become interactive.





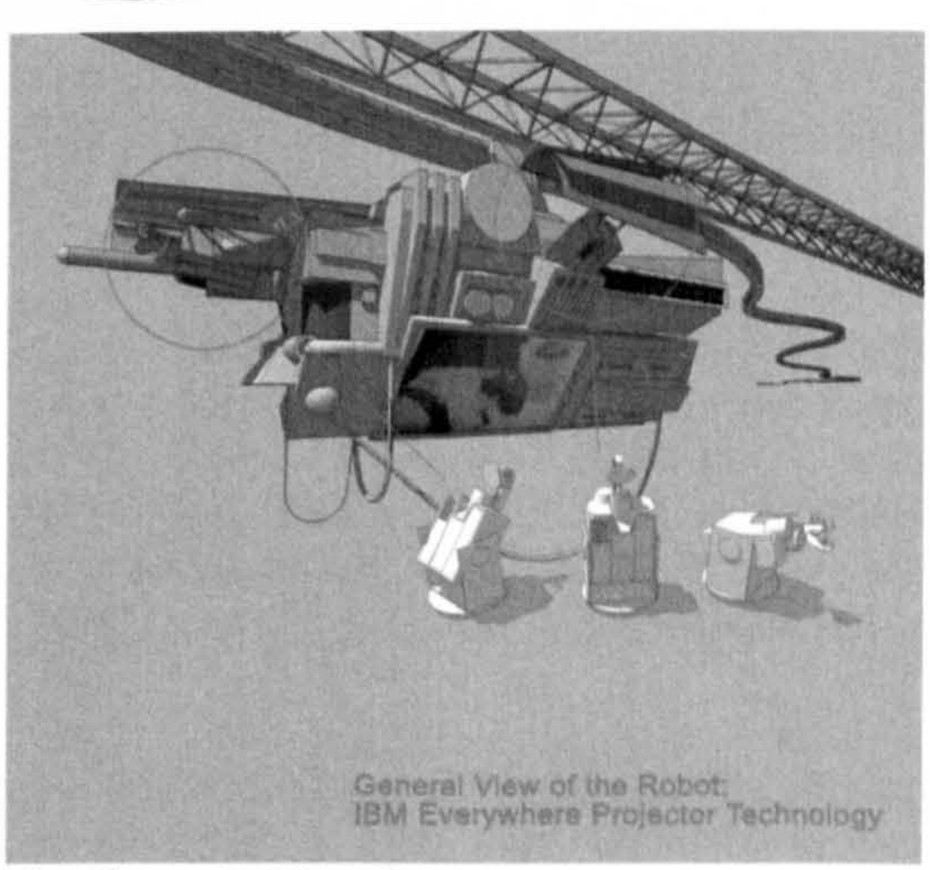


Figure 27: Views of the Gwangbok's robot.

Each Robot moves under rails over the street, supported by 34 structural portals. The Robots are made of a modelled polycarbonate and structural aluminium, and moveable canopies can be adjusted by distance to protect the screens. This gadget is controlled by the Interaction Research Centre, situated inside the 4 towers along Gwangbok Street. But the interaction, position, movement and lights of the Robot can be modified by users accessing and interacting with an internet web site.

During the Busan International Film Festival, or whenever it is required, the Robot can spread information, ads, clips, games and quizzes about the movies exhibited, interacting with the public and attracting their attention.

Figure 28: Model to study general aspect of the solutions to Gwangbok Street.

Nevertheless, in order to be a pervasive mechanism for declaring, representing, and querying the physical relationship between people, places, devices, and things, the Robot needs to be supported by continuous research, both adopting new technologies and improving them. The Interaction Research Centre would be thus an organization whose main preoccupation is designing, experimenting and maintaining systems, software and hardware, in order to produce new improvements to the interactive urban devices used at Gwangbok Street. It would cope daily with ubiquitous computing solutions for Gwangbok Street, perhaps being the first centre for this subject to be situated in the very field of research itself.

It is supposed that, in time, Gwangbok Street would incorporate many specific devices and services, such as wearable locators for people, various child care aids, disability applications, intelligent urban appliances, survey systems for the shops, Bulletin Board Systems exposed in open spaces, and other public utility services supported by both located and remote devices. The Research Centre translates the power of tuned interactions between people to the Gwangbok urban space through the creative contextual development of 'widgets', while the researchers simultaneously can debate the privacy issues and policies.

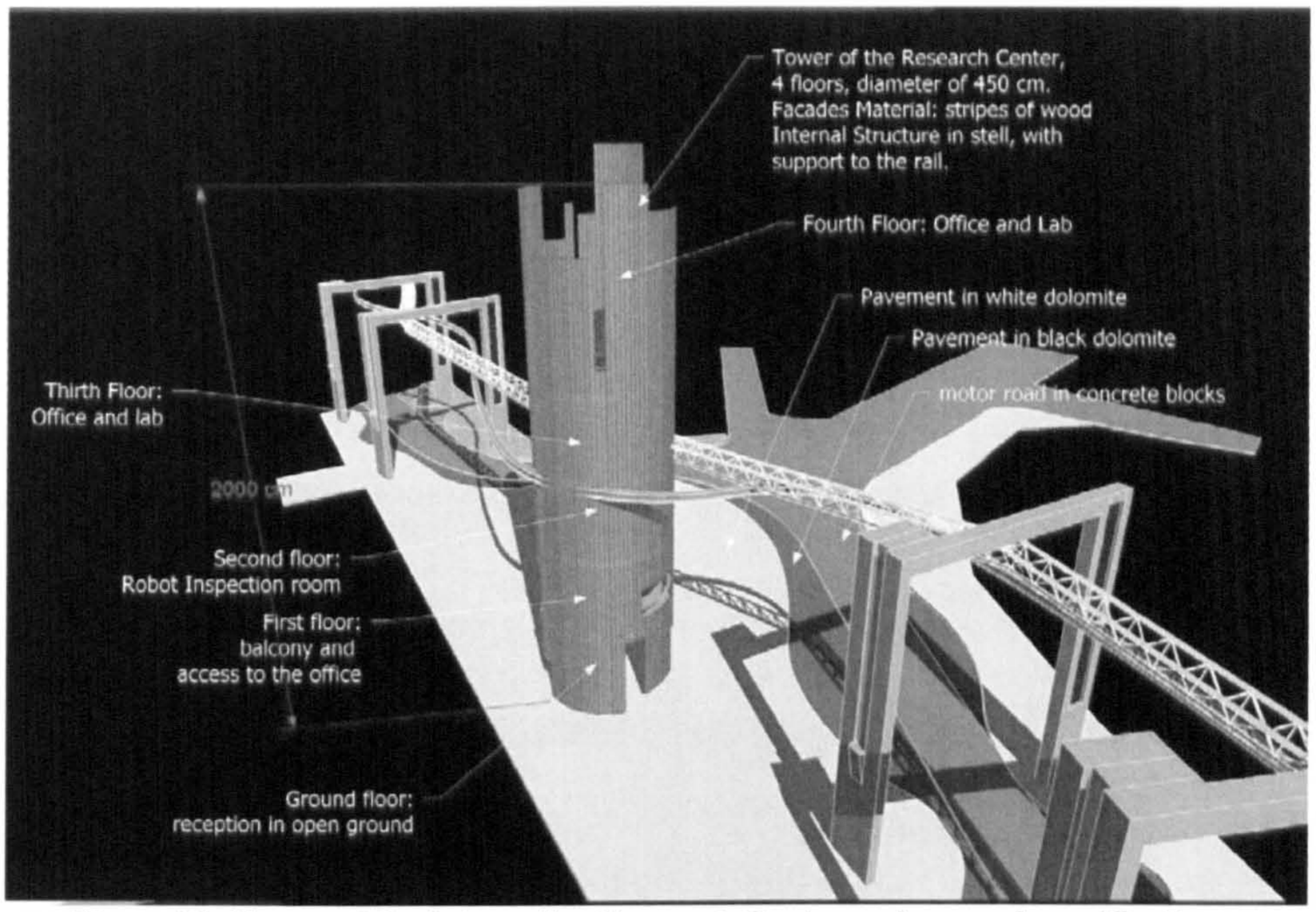


Figure 29: Tower of the Interaction Research Centre and general specifications.

The portal includes the streetlights and a luminous vertical message board and is made of painted steel. Since they were to look like gates and, more importantly, to be used at night, they were named '*Gates of the Moon*'. Gates and shapes on the ground would serve to attenuate the tedious ambience produced by the chaotic contemporary scenery.

Finally, it was proposed that the removal of a building to generate an open space near the Piff Plaza. This was seen as an option for creating an unbroken continuity of view within Gwangbok Street. For that reason, the design considered the addition of symmetrical lamps to mark solemnities in the square, for example those related to the festival. A very simple design was suggested so as not to interfere in the spontaneous use of space.

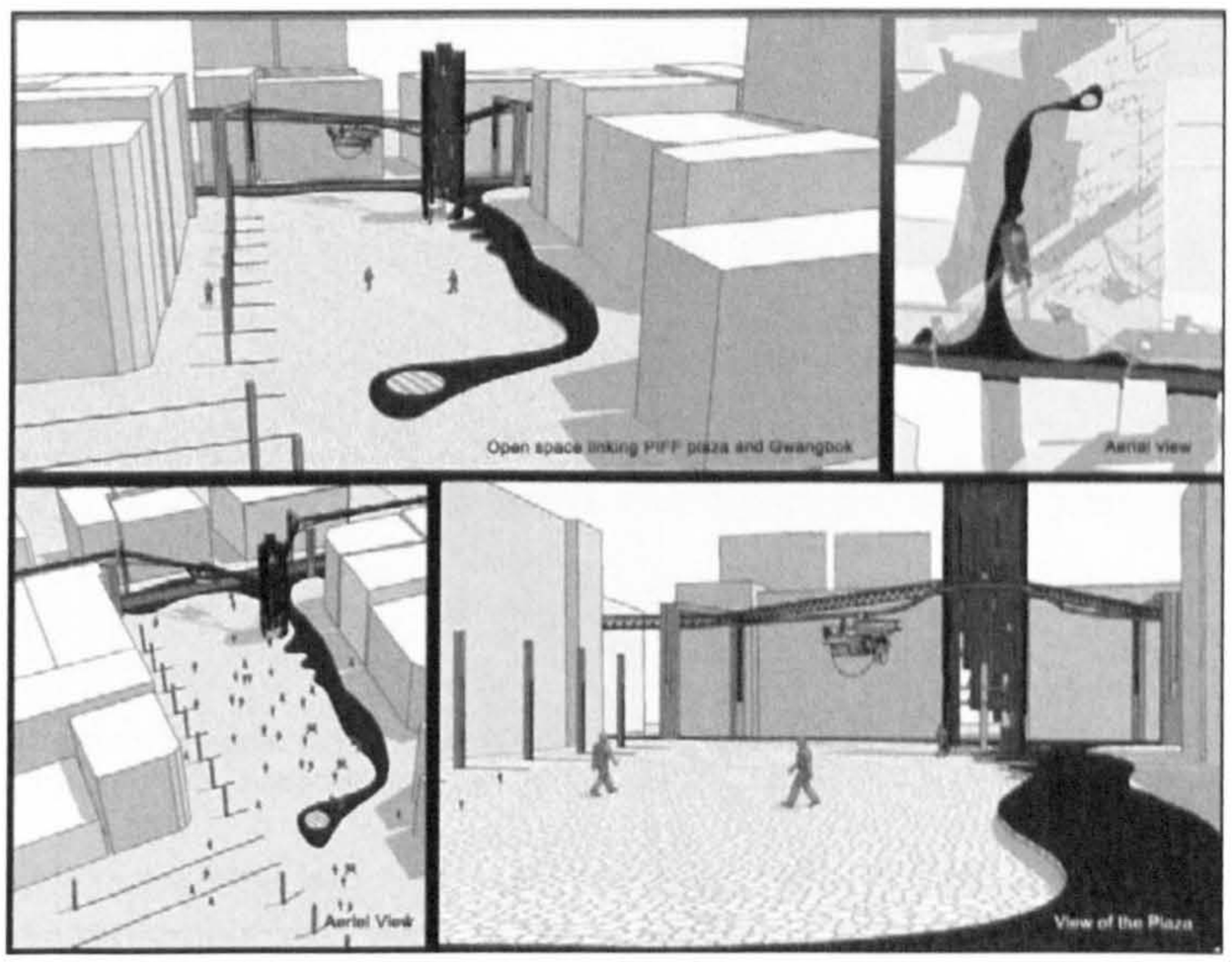


Figure 30: Scheme showing views of PIFF plaza with the open space resulting from the removal of a building. Details of Lamps, floor and the position of a sculpture are shown.

The solutions were expressed visually in drawings to which general comments were attached. These were presented in the original formats and it is worthwhile commenting on them. In relation to the open spaces, it was alleged that the solutions provided increased the space surrounding monuments and sculptures so as to permit their better appreciation by the public and the consequent reinforcement of local identity. In relation to the street, the solution offered was the transformation of the street into a place rather than a simple car route by decreasing the width available to car traffic, and qualifying it into small territories. As regards the shops, the solutions adopted by using IT through robots and portals were alleged to be able to make the interactions more diffuse, spreading them about the area and enriching the overall experience.

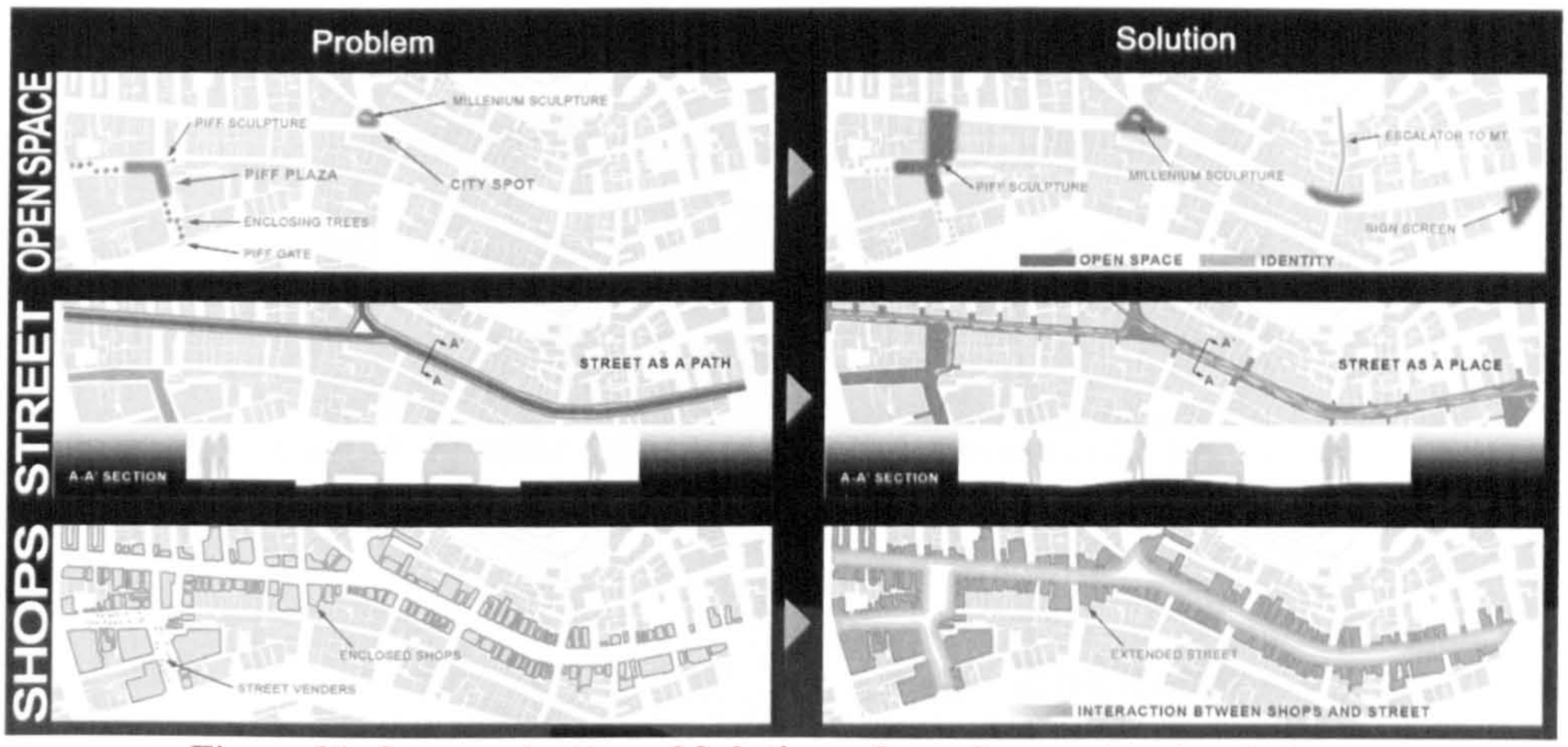


Figure 31: Summarization of Solutions. Open Space, street and shops.

As far as human movement is concerned, as this mainly involved pedestrian traffic, it was proposed that the solutions made for a richer kind of movement that would lead to more interaction between people and place. Thus, illegal parking would be eliminated and motorized traffic limited. Finally, the communication introduced by the robots and portals was seen to enrich communication and increase interaction.

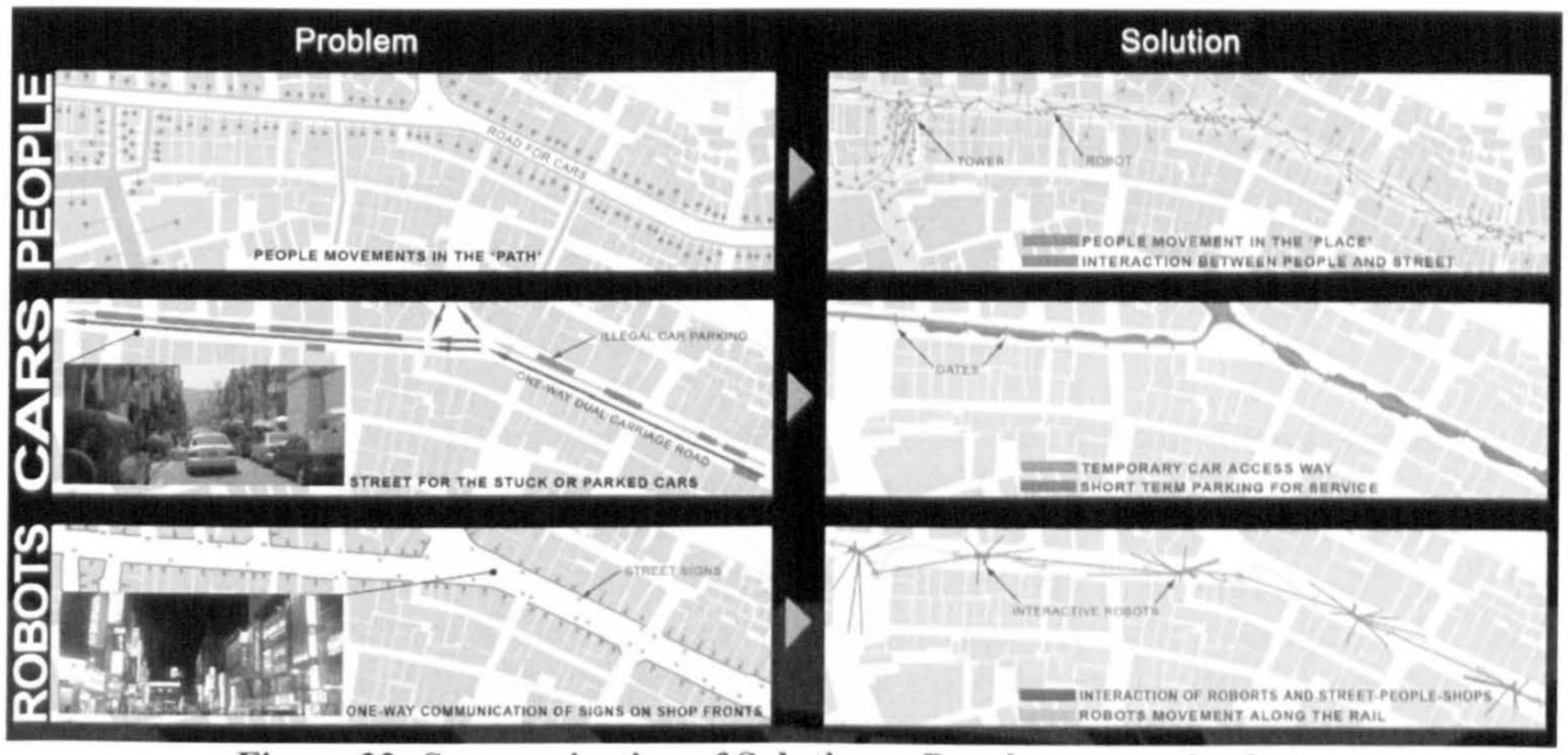


Figure 32: Summarization of Solutions. People, cars and robots.

Finally, the ideas for forms that inspired some solutions were shown in order to explain them: the waved design of the pavement was inspired by the ocean; the portals were inspired by the bridge cranes visible in the port; and the towers of the Research Centre by lighthouses. It was suggested that all these inspirational elements were familiar to Busan Citizens.

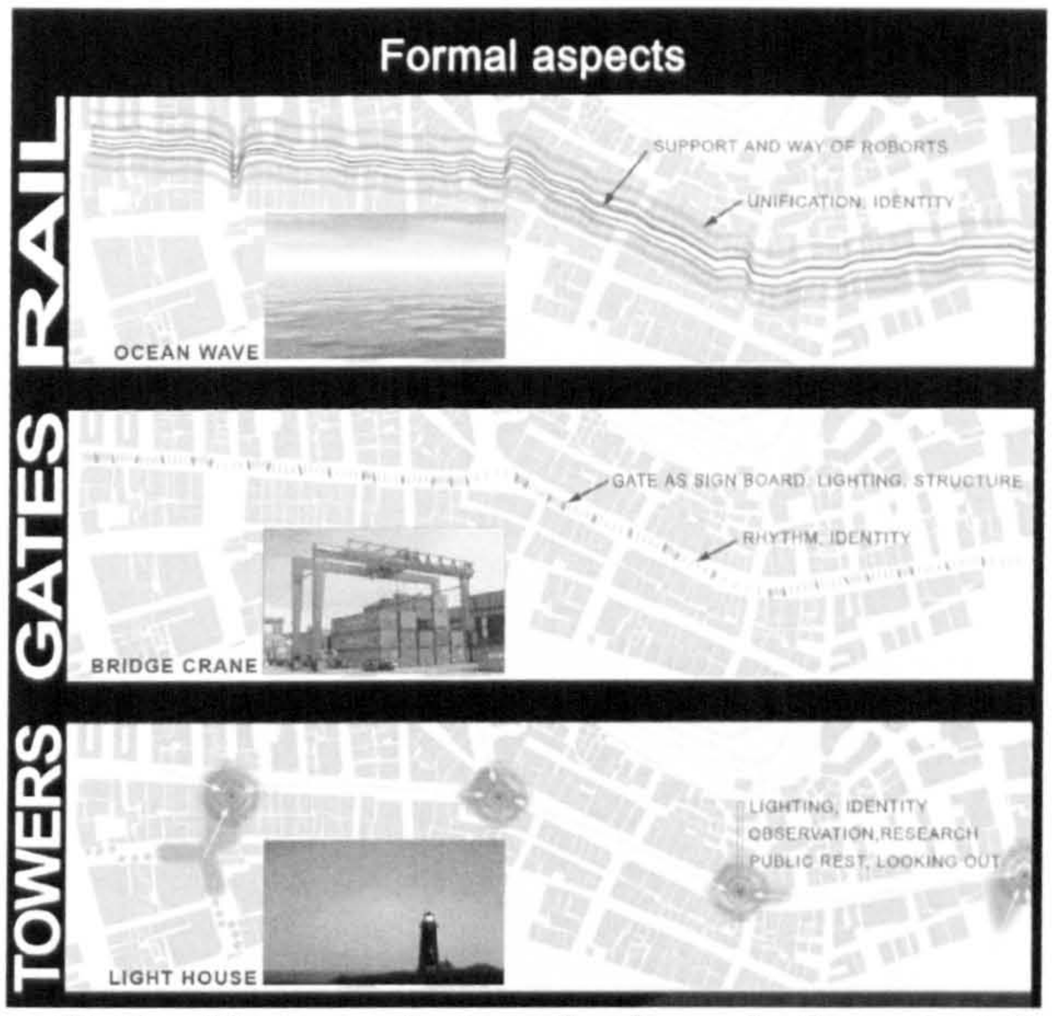


Figure 33: Familiar precedents to the shapes in Gwangbok Street.

5.4. Evaluation of the project

This section will address the evaluation of evidence presented in the project which can demonstrate that it satisfies (or not) the expected outcomes derived from the key research questions (see on page 103). In order to get a systematic view of this process and make it common to the cases dealt with in this research, the evidence will be described in the order of the list presented on page 103, in the section concerning the 'Expected results in terms of educational outcomes'. It would be useful to remember that the list is a result of an adaptation of Bloom's (1956) Taxonomy of educational outcomes. The outcomes, derived from the key research questions, were stated in attention to the logic to compare them throughout the course of the three case studies. Thus, instead of making the statement of outcomes by including only one general learning outcome in each case, similar outcomes were sometimes grouped under a question that was originally derived from the same key question. This logic seemed clearer, avoiding unnecessary repetitions.

Thus, the Gwangbok project, in its drawings and rationales, was examined considering the items of evidence that demonstrated that the framework gave the architects the means to:

1. Explain the qualities of place in terms of Territoriality, Privacy, Identity and Ambience;

The explanation of qualities of place expected by this outcome is a way of enabling the analysis of the place, seeking the identification of conflicts on the one hand and permitting the creation of correlations with digital technologies components on the other hand. The Gwangbok project can only partially explain those qualities. The rationale introduces a short explanation about the qualities when it analyses problems affecting the area. However, the qualities are mentioned as being attributes of architectural spaces, without an explanation connecting them to public places. The deduction of problems for the Street using the four qualities is the main tool used to detect conflicts when analysing the material delivered to the architects' teams, material which mainly took the form of photos and texts. However, there is no presentation of a theory that permitted such

analysis and the consequent scrutiny of detected problems; neither is there a proper bibliographical reference to the sources of those concepts. Another point about the qualities of place is that they were used only in the identification of problems, and the solutions using IT did not mention any correlation with them. The control of communication between the private and public sector was a chosen strategy to improve local identity, but none spatial topology was related. Instead, it was described as a procedure to transform the place into a research area concerning '*interactiveness*' using IT, and it was proposed as an organizational principle overlapping the physical organization.

2. Explain the topology of the elements of place in terms of centrality, enclosure, internal area, internal directions and entrances;

The explanation of that topology correlates physical elements of the place with the aforementioned qualities and permits inferences about the utility of digital technologies components (their functions and technical specifications) so as to reinforce those qualities by acting in accordance to that local topology. In the Gwangbok project there was no reference to the topology of the place in this sense. Instead, concepts from Rapoport (1977), as ordinations of space, meaning, time and communication were used in an effort to understand the place.

3. Given a place, identify the conflicts between spatial elements and activities and elicit how they interfere on the qualities of place;

The Gwangbok project partially achieved this outcome. The identification of conflicts, as it has been mentioned in the Chapter 2, is carried out by means of the technique of reading spaces, which consists of using all the possible evidence to detect conflicts between people's activities and spatial elements. Those evidences include data such as photos, interviews with users, video footage addressing a particular phenomenon and so on. As was mentioned in the first outcome analysed, the qualities of place guided the inferences about the existence of conflicts, so they were identified from the pictures and texts delivered to the contestants by the city council. However, this process was not as systematic as that prescribed in the framework, which, as is mentioned in the section 3.6, recommends the use of tables. Since those tables were not drawn up, the conflicts could only be interpreted intuitively, and they were generally taken to be spread over the street without any concern for frequency and the location of the occurrence. As the conflicts were mentioned generically with reference to Gwangbok Street, there is no specific account of the deduction of the interferences caused to the qualities.

4. Compare types of digital technologies components (to sense, to act, to represent the place):

There is no comparison of types of IT; this fact expresses the absence of such a theoretical approach from the framework during the period of the Gwangbok Competition.

5. Explain the topology of digital technologies components and its potential interference with the place's qualities (in other words to explain the correlations between interiority/exteriority, visibility and appropriation and the functions of the digital technologies components);

This outcome was not achieved in the Gwangbok Project. This can be considered as a reflection of the knowledge of components of IT relative to their functions and technical specifications and their relation to the general spatial principles that are at the root of qualities such as territoriality, privacy, identity and ambience. As was shown in the tables in section 3.6, such an explanation would make it clear how an IT component, for instance a display or a servomechanism, is being used to reinforce some spatial aspects that determine the qualities of place. In the Gwangbok Project, a servomechanism was used but it was justified by means of a general idea of enabling the interaction between private and public realms. Among many other possibilities for the development of gadgets by specific design, a Research Centre was suggested to promote the investigation of interactive methods by using IT gadgets. However, those digital technologies components were not related to the place's physical properties in such a way that would clarify how they could reinforce the qualities of the place that have been affected.

6. Create solutions to the identified conflicts by using digital technologies components and spatial elements;

This outcome was partially achieved because not all the conflicts were solved by IT use. The solution finally adopted for the Gwangbok and Piff Plaza areas was a combination of organizational and physical arrangements in the project. Proposals concerning the organization of activities included the prohibition of illegal parking, the suggestion of management of timetables to separate activities during the day and the creation of a centre to research IT '*interactiveness*'. Physical interferences included the design of a trail to support eight moveable gadgets named "robots", each including a Laser projector, a display message board, two big television screens, two video cameras, and three of IBM's Everywhere projectors to enable interaction when people 'touch' the projected images by casting their shadows over the surfaces of the ground and the walls. Portals were distributed in the extension of the street supporting the trail and they included the streetlights and a vertical luminous message board (see on page 200). Furthermore, other physical recasts were suggested, such as the creation of four cylindrical towers, distributed in strategic positions along the street, in order to accommodate the Interaction Research Centre. Justifications for these IT-utilizing solutions were given based on the need to reinforce local identity, which was elected as the main affected quality. Other conflicts, relating to territoriality, privacy and ambience, were solved by the recasting of physical elements *without* the support of IT. Therefore, according to this evaluation, the design solution proposed for Gwangbok contemplated a unique quality, which was Identity.

7. Implement the IT solutions as an integrated part of the place's topology;

With this outcome it was intended to observe whether or not a solution using IT was intrusive inasmuch as physical refurbishment would be required to support it. In this sense, the solution to Gwangbok Street was integrated with the place but it required essential physical interventions in the portals and trails to support the movement of eight robots over the street. Thus, this outcome was partially achieved. The dominance of horizontal directionality and other aspects associated with that were not interpreted so as to provide solutions that considered less intrusive modifications of physical aspects. In fact, quite the opposite was the case: for the sake of a 'singularity' to improve local identity, the passage of oncoming vehicles in the direction of the street was 'broken' by the curved and irregular design of the pavement and the path on the ground.

8. Justify the use of each IT component in terms of their contributions to the solutions of conflicts, eliciting their influence over topological characteristics such as interiority/exteriority, visibility and appropriation;

A general justification for the use of IT was given, regarding conflicts which affected local Identity as the most important ones. However, none of the digital technologies components applied in the design solution were justified in terms of their influences over topological characteristics related to the local qualities. This was presumably caused by the fact that the framework was not entirely in place at that moment.

9. Plan the IT system together with physical interventions that will help to solve the detected conflicts;

This outcome was only partially achieved. The Gwangbok project presented physical interventions to be made simultaneously with the application of IT resources in the street. However, the IT complements proposed were not a system, in the sense of being a group of parts assembled together with a structural relationship between them, such as function, technical limitations or types of linkage to other parts. It was suggested that instead, an institution, the Interaction Research Centre, would stay in charge in order to create the systems of IT, researching into how to make the interaction between people and activities in the street richer and more interesting, crossing between the public and private domains with IT gadgets. Physical interventions were suggested in association with the IT solutions given. As has been said, digital technologies components were

used mainly in the trial to solve conflicts that interfered in the identity of the street. While applied IT was used mainly to solve problems related to identity, physical interventions were used to solve other conflicts such as those that interfered with territoriality (illegal parking, pedestrian walkways, absence or lack of transitional spaces between the inside and outside of shops etc), privacy (temporal separation of activities by means of a timetable), and ambience (specification of materials and urban furniture).

10. Plan physical changes to support the IT system planned;

The Gwangbok Project's physical interferences were planned and detailed, except the definitions of the interior of the four towers that would accommodate the Interaction Research Centre. Those towers were left empty because the requirements for the Research Centre were not clear enough to demand an architectural programme. The floors were vaguely specified and the reason for that was that the towers could be made to house future technical requirements by being made internally flexible. That flexibility, however, should obey the criteria laid down in the definition of the project, which established that the towers should be cylindrical, a formal characteristic inspired by the lighthouses that are a common sight in Busan. This can be regarded as a partial account of the resultant space demanded to support digital technologies components used in the project. Since clearer specifications relating the space inside the Research Centre were absent, there was no need to specify the required activities that they would be in charge of.

11. Specifying the spatial requirements for the IT system adopted;

Other evidence can be interpreted as a lack of understanding about how some digital technologies components work in the place, such as the use of the IBM Everywhere Projectors. Those devices can convert simple surfaces, as walls and ground into shadow-interactive interfaces. They still were, at the time of the contest, being developed by IBM, and that company was consulted to provide more technical specifications. Those projectors were incorporated in the robots as an alternative way of absorbing future modifications in the technology. However, neither the question of the space on which to project the images, nor the study of adapting the surfaces to multiple-use was assumed to be an essential aspect of the project. The drawings refer to that situation by showing computer generated models in which it is possible to see projections overlapping facades and ground, as it is shown in Figure 34 and Figure 35.

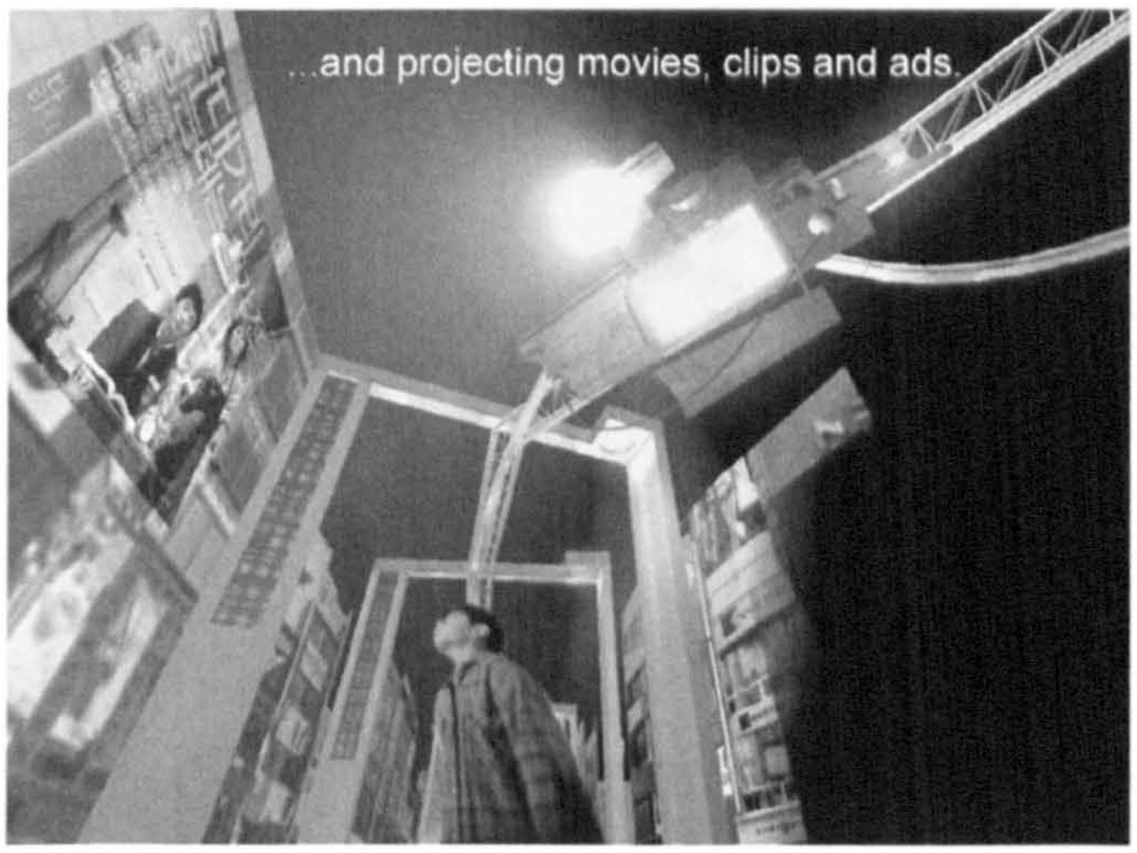


Figure 34: Everywhere Projector transforms the facade of a building in a screen, overlapping visual elements.

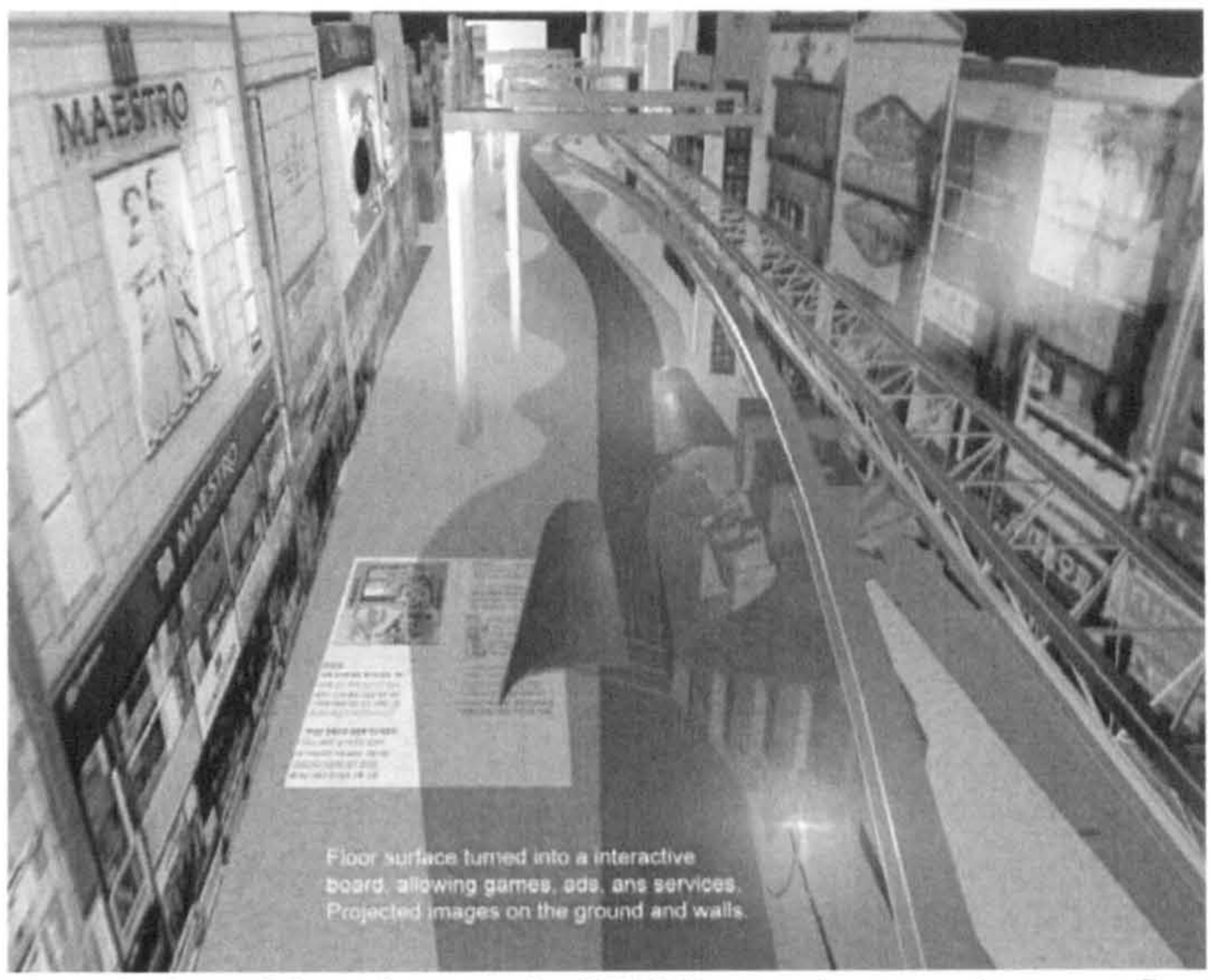


Figure 35: General description of functions to the IBM Everywhere projector reflects the inaccuracy to specify the relations between IT component and physical space required.

It was assumed that specificities of spatial requirements to use that IT component should be studied by the Interaction Research Centre, an alternative solution to the inaccuracy in the specification of the functions of the component.

12. Plan schemes of IT systems as gadgets to be used in the place;

This outcome refers to the evidences that show that the system of digital technologies components was planned strategically within several sets of circumstances, like scenarios, carefully explaining the diversity of interactions between components, activities, and spatial elements of the place. Those schemes should integrate all the particularities of the system proposed together with physical aspects. In Gwangbok Street Project there were not such schemes focusing on the totality of the project but small snapshots abstractly illustrating some situations, as the

Figure 36 shows.

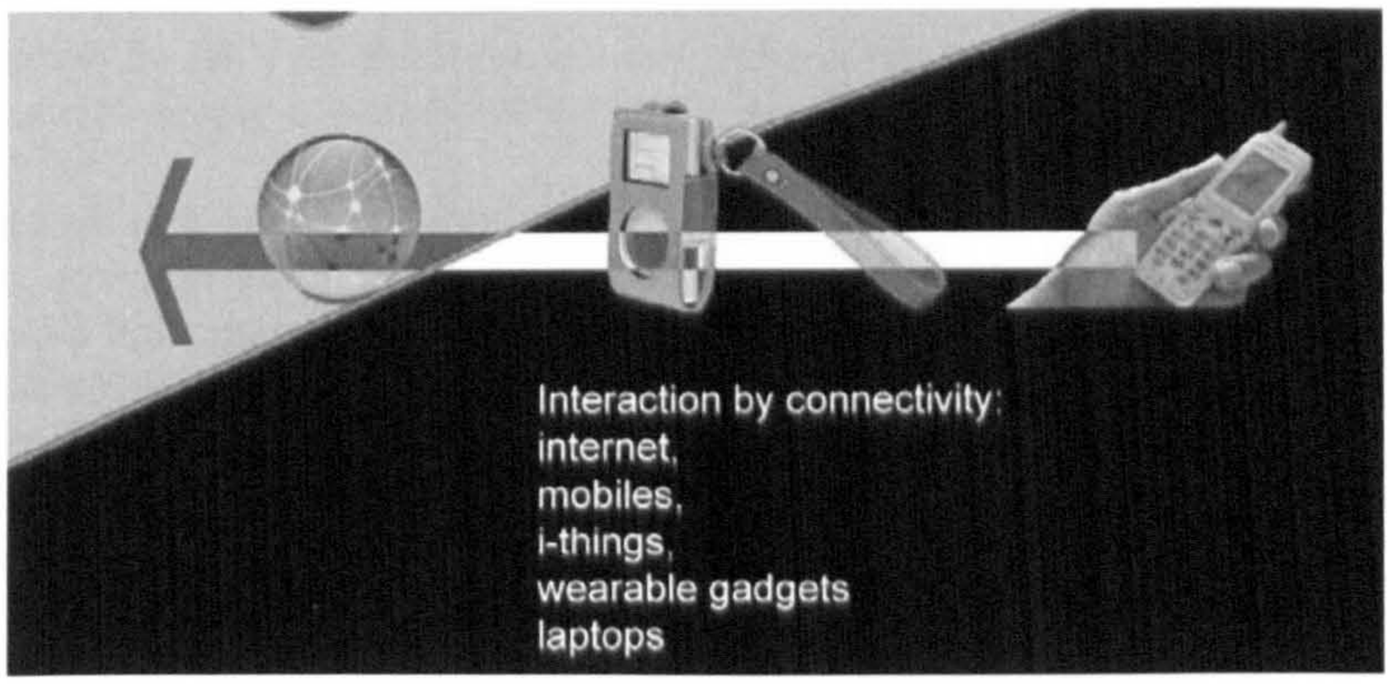


Figure 36: A snapshot scheme about interaction and connectivity

13. Specify the digital technologies components and gadgets functions in the system as to permit exchanges with other fields as computing sciences;

Since it was suggested the creation of an Interaction Research Centre to the Gwangbok Street Project, only general aspects of IT usage to that place could be discussed within interdisciplinary exchanges. Many aspects concerning the way that the various components were assembled together were not specified, suggesting the need of further development. Mentioning the idea of interaction,

the rationale elucidate that the Research Centre should specialize in ergonomic interfaces and haptics technology as a general link to other fields.

14. Justify the solutions adopted, clearing the accomplished advantages.

The final justifications to the solutions did not clarify them in terms of advantages, despite being mentioned that seven design solutions were been proposed. The rationale only reports about refutation of the others options in general terms, and the main one was the intention of avoiding heavy removal or recast of existent buildings and spaces. Justifications to the creation of the Research Centre were emphasizing the idea of *"tuning"*, which means the constant adjustments between machines and human activities by incremental modifications. A drawing representing a summarization of the solutions (see page 118) introduced other justifications but only the use of robots were associated with the application of IT as to improve local identity.

15. Criticize the solutions designed to feedback the theory.

In the rationale to Gwangbok Project, there was not criticism addressing to the feedback resulting from the application of the theory. However, criticism helped the design by delimiting the focus of the design solutions. The criticism of solutions was mentioned preliminarily in the rationale when it is said that seven design options were generated and just one was chosen, by the refutation of the others. The alleged criteria to refute the others (see page 212) were that there were an intention in avoiding the strict focus on small details, as the emphasis on the design of urban furniture and specification of materials as a means to grant a visual identity, or providing solutions which would require heavy recast or removal of buildings and existents spaces. Thus, the interpretation of such evidence was that the architects considered that IT could provide a light way to refurbish urban places and, at the same time, it could offer the means to deal with what they called *"the unmanageability"* of the urban scene. According to that rationale, at the page 212, it is mentioned that:

> "*When a system is unmanageable, we have three options: to reduce complexity, to change the organisational structure (how control operates), and to alter our attitude to unmanageability. The design solution to Gwangbok related to the first option was a simplified functional design of the urban space, establishing zones and specifying their elements. The design solution to the third option was including a Research Centre to seek continuously new solutions to interaction using Information Technologies devices on Gwangbok Street. (...) The option concerning a change in the controls was establishing new ways to people interact with the street, in order to achieve a recognizable identity.*"

Thus, the criticisms that can be deduced from those principles were means to provide a reduction of the complexity, a change in the organizational structure of the space and a change in the disposition of people towards the apparent chaos in the urban scene. Only one principle was barely connected to the framework developed in this research, which was the second, corresponding to the means that that structure would be supposedly supported by IT in order to promote communicative interaction among diverse social sector, achieving identity. This idea, however, is far from a spatial oriented solution, once it does not specify the physical means through which that interaction will happen, neither how it is spatially connected to the identity of place.

Finally, summarizing the results of the outcomes obtained through the analysis of the project, it is possible to get the following table:

Expected outcome according to the key questions	**Observed outcome**	**Description of the evidence observed in the drawings and in the rationale**
1. Explaining qualities of place.	Partially achieved.	Four qualities used to deduce problems. However, there are not a proper analysis in the rationale;

2. Explaining topology of elements of place.	Not achieved.	There is no reference to those concepts.
3. Identifying of conflicts.	Partially achieved.	Conflicts generically identified and related to qualities. A systematic analysis is lacking.
4. Comparing types of IT components.	Not achieved.	There is not any reference to those concepts.
5. Explaining topology of IT components.	Not achieved.	There is not any reference to those concepts.
6. Creating solutions with IT.	Partially achieved.	Not all conflict were solved with IT solutions.
7. Creating solutions Integrated in the place.	Partially achieved.	Incomplete integration with place topology, requiring heavy physical modifications.
8. Justifying the use of IT.	Partially achieved.	Only a general justification was given.
9. Planning a system of IT	Partially achieved.	The components were not thoroughly specified as a system.
10. Planning physical supports to IT components.	Partially achieved.	Details to the towers of the research centre are missing.
11. Specifying spatial requirements to IT.	Not achieved.	Details of IT components and their spatial requirements are missing.
12. Elaborating schemes of IT systems.	Not achieved.	There were not schemes referring to the use of IT components.
13. Specifying technically IT components.	Partially achieved.	Some specifications were considered to be made by the team of the research centre.
14. Justifying the solutions in terms of advantages.	Not achieved.	Justifications were generically done.
15. Feedbacking to theory.	Not achieved.	There is not feedback addressing to the improvement of theory.

Table 23: Outcomes achieved in the Gwangbok Street Project.

5.5. Framework amendments

This section address the development of the theoretical framework that follows each case, as was suggested in section 4.4.3 on page 90. This development results from the case study method, which permits, through the analysis of results, the shaping of a theory. However, by the time of the Gwangbok Street Contest, in 2005, the theoretical approach was not accomplished (see section 4.1 at page 77). As a matter of fact, with regard to the systematization of this research, the Rationale for Gwangbok contained what the framework in the form in which it was utilized at that time (see 'Gwangbok Project: Rationale', at page 205).

The resultant project was, in this sense, a starting point for contemplating a framework that would be able to support the design of the use of IT in Ubicomp systems applied in urban places. Thus, the '*improvements of the framework*', from that starting point, actually corresponds to the very generation of key research questions in order to have a more systematic approach with which to find answers.

It was clear, by the end of the Gwangbok project, that many inconsistencies were present in the solutions. The most notorious of these were those which referred to the absence of a fair way of justifying the use of IT as a supporting mechanism for solving problems in the place concerned. The main contradiction was that, despite the use that IT addressing that particular case, with regard to the task of specifically strengthening the quality of Identity, the solutions designed did not present a straightforward correlation with local attributes or activities. As a solution proposed in the

project, it was suggested that the affected quality of identity would be strengthened through interactions promoted by IT gadgets. The design of those interactions would be a function of an institution, in charge of researching the means to develop the integration between people, cultural events and commercial opportunities, the Interaction Research Centre.

It means that, despite addressing the question of local identity, that same solution could be given for many other streets, in similar cities around the world. Few correlations between the physical spaces of the street, the activities lodged in it, and the relative flux of information between both informed the proposed design of IT devices and their physical supports. As a result, not only were technical specifications vague, but also the definitions of some spatial issues related to the IT components. These were the main points which were suggested for further development, and have feed backed the framework.

Chapter 6:
Case II: Fargate Street

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Fargate Street, in the city centre of Sheffield, United Kingdom, was the area first chosen in which a hypothetical urban refurbishment would take place so as to permit the study of the application of the framework developed in this research. That hypothetical refurbishment provided the scope for the exercise of the discipline as set up by the "*Interactive Urban Visualisation Modelling*" module, which was taken from the Master of Science course in Architecture at the University of Sheffield, during the spring semester of 2006, in which I was involved as the investigator of this research.

Fargate Street was chosen because its area and surroundings were fully represented in the range of maps covered by the SUCoD - Sheffield Urban Contextual Databank (Peng 2001). SUCoD is an experimental on-line urban information system storing multidimensional and multiple types of urban contextual data that can be accessed by architecture students and architects directly for urban design analysis and design development (Peng 2005). SUCoD contains a limited area of Sheffield's actual urban region. The fact that Fargate Street's surroundings were included was considered important in allowing the students the option of access to more material to support their project. Among other resources, SUCoD permits architects to retrieve urban contextual information about Sheffield, including 3D VRML models, HTML documents, and digital maps. It also supports collaboration among researchers and designers who are concerned with better urban design modelling tools.

Another reason to choose Fargate Street was the fact that the area is smaller than Gwangbok Street, which appeared to be suitable in the context of the discipline. On the other hand, Fargate Street was considered similar to Gwangbok in some senses, as it is situated in a central pedestrian urban area, and has been refurbished many times since the Victorian era, when the city was first settled (Hey 1998). In common with Gwangbok, the commerce in Fargate Street has become mostly dedicated to fashion, gathering together many shops engaged in this line of business.

In the course module '*Interactive Urban Visualisation Modelling*' delivered in 2006, five students architects were asked to come up with ideas for a project involving the urban refurbishment of Fargate Street, providing solutions to a list of previously identified conflicts. They were asked to use preferable digital technologies components as a means of supporting their solutions and it was also required that they should use the developed framework of this research to justify the solutions provided.

A summarization of the framework developed since the occasion of the Gwangbok Street project, in 2005, was introduced to the team of students in a lecture (see the Framework in 2006 at page 238, in the Appendices). Together with that summarization, the students also received a report

containing a detailed description of identified conflicts between activities and spatial elements at Fargate Street (see the Fargate Project: Conflicts Report, at page217).

The period for the development of the project corresponded to the timetable for the module itself, which was of about 15 weeks duration, lasting from 9 February to 30 May 2006. In the lecture of 9 February, I introduced the architects to the framework, with the support of a slideshow presentation. I attended all days of the course, observing and talking to the architects when necessary, but actual support for the development of the project was reserved to two occasions when the course tutor and I ran review sessions (tutorials).

To the group project stage I, according to the original outline of the course (see page 215), the exercise was introduced with the following text:

"*The area of Fargate has been the very heart of the City of Sheffield since the Victorian age. Like many places in the city, the original characters of Fargate are lost due to the contemporary urban changes. An initiative to improve the current state of the Fargate has been launched jointly by the Sheffield City Council and the Sheffield Society of Architects and Urban Designers. The Committee is now calling for a proposal of an urban space improvement scheme through the means of digital augmentation. Digital augmentation is defined here as an act of developing and deploying information technologies to resolve some or all of the spatial conflicts identified. You are invited to enter the competition by submitting an outline proposal in response to the current conflicts identified in a latest urban space analysis report, which can be downloaded from the website. Your proposal should be prepared as Web page(s) publishable through the competition's website. There is no specific web-page format to follow but your proposal should provide the following information content:*

- *2D Plan/Section/Elevation delineating the outline design proposal in a 2D format;*
- *3D Urban Form visualising the outline design proposal in a 3D manner; and a*
- *Narrative conveying the urban experiences engendered by the proposed digital augmentation*

In addition, your Web page(s) should be accompanied by two essential digital files: (a) 2D plan/section/elevation CAD file, (b) 3D Urban Form CAD file."

(From text reproduced at page 215)

To the Group Project Stage II, the following text was presented in the same course outline:

"The 'Digital Augmentation of Fargate – Sheffield' competition has attracted a fair number of excellent proposals. All winning entries have been exhibited on the website published by the Sheffield City Council to launch the 2nd stage of the competition. You are cordially invited to submit a 3D detailed design proposal by choosing to work on one of the winning digital augmentation outline schemes. To assist the reviewing process of the detailed design proposals by the Committee as well as the general public, please submit your design proposal to include the following information content:

- *A VRML Model of the proposed design which can be uploaded and combined with the contextual VRML model as published on the Sheffield Urban Contextual Databank (SUCoD) platform;*
- *A set of Before vs. After digital images captured from the SUCoD contextual modelling platform; and*

- *A Project Report of no more than 500 words, presenting the key ideas/concepts underpinning the 3D detailed digital augmentation design.*
Individual Essay of about 3000 words (40%)

(From text reproduced at page 215)

However, during the evolution of the project, some aspects from the original outline were modified in agreement with supervisor and the students, and the required outcomes were simplified. Among those simplifications, the requirement to present the results by using webpage format was abandoned. Instead, it was agreed that the students would present the whole project in CD-Rom form, using multimedia resources.

6.1. The urban place

Sheffield is a city and metropolitan borough in South Yorkshire, England. The most recent estimates of population are for June 2005, and give a figure of about 520,700 people (Sheffield, City Council of 2007). It is among the eight largest cities outside London, with a total area, including the borough and the city, of about 367.94 km^2. Founded by at least the 8^{th} century, the city has based its economy on the production of steel since the Industrial Revolution. At that time, the growing of population and economy led to Sheffield being granted its city charter, and was thereafter officially titled the City of Sheffield.

By the 1970s and 1980s, due to international competition and automation in the production of steel and due to a crisis in the national production of coal, Sheffield suffered a reduction in its wealth and population. After that, it recovered during the followings years, thanks to plans that dealt with its economic development and replaced the role of industry at the core of its economic activities.

Figure 37: Fargate, decorated for visit of Queen Victoria in 1890 (Sheffield, Local Studies Library of 2007).

By the 2000s, Sheffield has become a major retail centre and home to many High Street and department stores, consolidating its development towards an economy that struck a balance between commerce and industry. With the alternative development of commercial areas surrounding the city, such as the Meadowhall Shopping Centre, built in 1990, the city centre entered into a period of decline. Since then, attempts to regenerate the centre focused on the creation of conditions to support the recasting of commercial zones, and also improving the quality of related services and resources, enriching the public places where they are located. This was the context for the exercise proposed in the '*Interactive Urban Visualisation Modelling*' module regarding the refurbishment of a commercial street.

Fargate Street was probably formed in the 17th Century from medieval paths. By the 18th century it became a commercial street and its commercial vocation can be deduced from early photographs (see Figure 37). It had become a popular pedestrian area of Sheffield by 1970, when it was closed to car traffic. From that time on, it became a wealth of high street stores, most of them related to fashion, being also a place for street entertainers, musicians and specialist markets. Fargate is delimited by the Anglican Cathedral at one end and the Town Hall Square at the other and is linked to other significant places and areas by Barkers Pool and Surrey Street (see

).

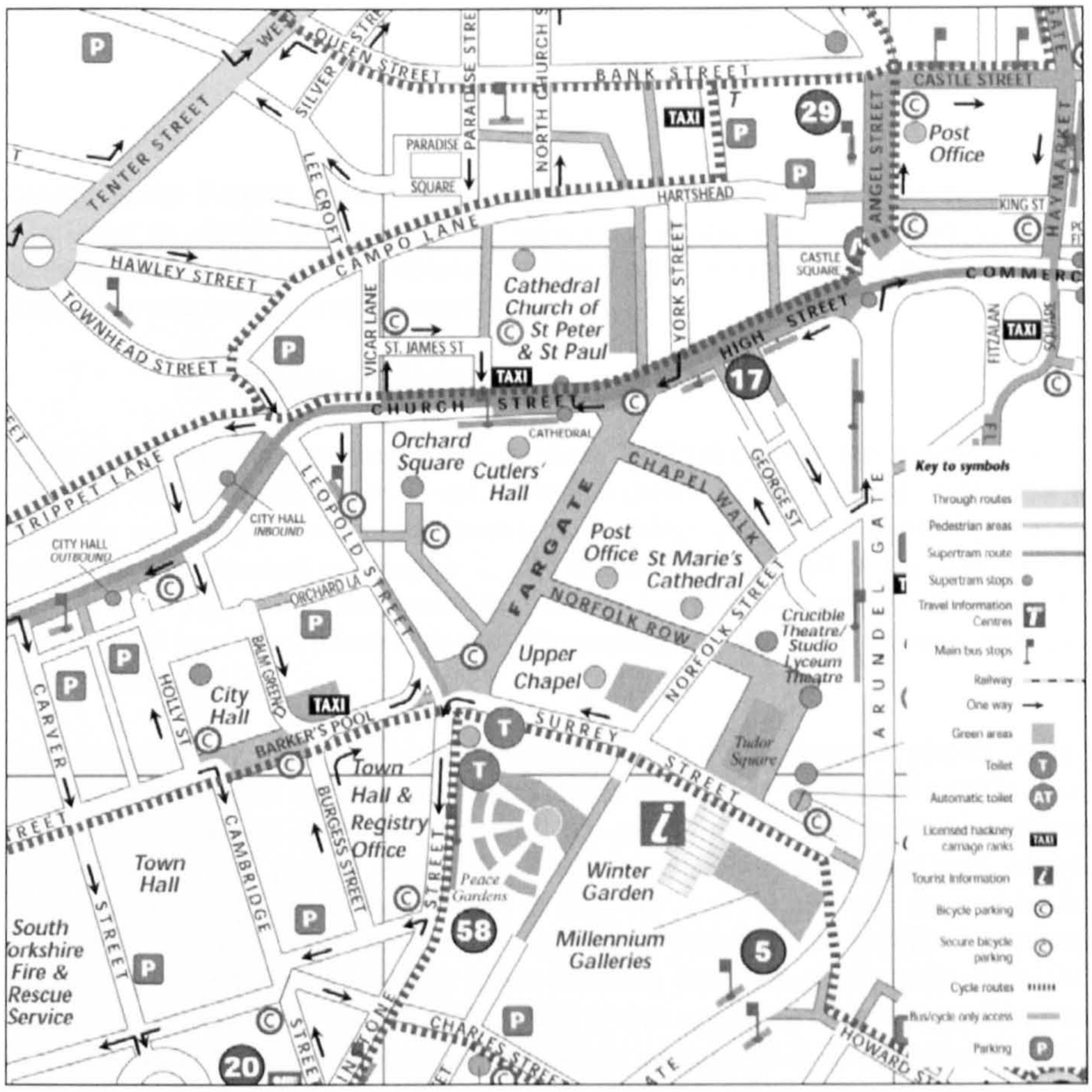

Figure 38:Map of urban milieu of Fargate Street (Sheffield, City Council of 2007).

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Over the years Fargate Street has gone through many structural transformations, including the improvement of basic services such as gas, water and electricity, but it is mainly the visibility of facades and pavements that is most noticeable. Old photos show a variety of types of urban furniture, sculptures and other elements in use at other times. A diversity of architectural styles is present in the facades, and the main changes in these were caused, as it can be deduced from pictures, by attempts to improve particular properties and the public area, substituting old buildings and adapting the urban design to suit new conditions, as is the case, for instance, in the transformation of the area in pedestrian in 1970, as is evidenced by a public information display in the street. By the beginning of the 1990's, it was completely paved and the furniture had changed.

In 2006 the area near the Town Hall was again paved on the occasion of a nearby building's refurbishment.

By the time of the exercise, it was observed that Fargate Street had few shops with an area smaller than 100 m2. A small bakery, a jewellery shop, and some few opportunistic shops such as Card Shops were the exceptions, all of them situated near the corner of Church Street. However, it was observed that in an attempt to adapt to the ever-changing market all the shops were constantly being refurbished or modified in respect to their facades or displays.

6.2. Problems identified

When focusing on the Fargate Street project, a distinction between the problems identified should be made, in order to clarify the analysis of framework interference. The students were given a report containing a list of identified problems, and they were invited to accomplish that list on their own by visiting the site and identifying conflicts.

a) Report of conflicts

Thus, a report containing the results of conflicts identified in the street was given to the students at the beginning of the semester. Prior to the commencement of the module, I made a survey of Fargate Street by applying the technique known as '*reading space*', developed by Malard (1992). That technique was mentioned in Chapter 2, and it has been adapted in the composition of this framework. Through the use of that technique it was possible to identify 12 conflicts between spatial elements that are either missing or malfunctioning, and the activities that took place in the Fargate Street urban area.

That survey was made by means of local observations and the analysis of photos, with the local visits taking place from 12th to 19th of January 2006. According to Malard (1992), the *'reading space'* technique should take in consideration all the possible data that could be collected during the time of the design of the project. This is justified by considering the actual work of architects in their offices, while dealing with design. When, in a survey to *'read spaces'*, the architects consider all possible data in a period, that would make the survey feasible and reliable to the context and would avoid long and costly methods. The report resulting from this was introduced to the students on the first day of the module, reminding them that it was supposed to represent first contact with the project site in order to depict general problems (see on page 217). I suggested that the students should consider visiting the place themselves to do their own surveys, reading spaces and identifying conflicts, in order to get a complementary view.

As a result of the consolidation of the framework, the report introduced to the students focussed on the identifications of conflicts that interfere with the four qualities of place: territoriality, privacy, identity and ambience. Such a concern was also present in Gwangbok Project, but without a systematic approach at that time. In the case of Fargate, however, that technique permitted the identification of 12 conflicts interfering in all the qualities, 6 of them interfering with territoriality, 4 of them with privacy, 9 of them with identity and 7 of them with ambience. In terms of frequency, 8 conflicts were observed continuously throughout the whole day, whereas 3 conflicts took place only from morning to afternoon. Only one conflict was identified to affect the area by night.

According to the interpretation of the survey, the conflicts were caused in connexion with the following spatial elements, which were missing, misused or malfunctioning:

- Canopies or other protective elements;
- Transitional areas in the shop entrances;
- New design and layout to pavement;
- A central point, monument, sculpture, or fountain;
- Benches;
- Urban solutions or equivalents to the problem of shop supply;
- Thoroughfares for cars;
- Satisfactory Shapes of buildings;
- Visual communications ordered;
- The satisfactory layout of urban equipment and furniture;
- New Lighting project;
- Clearing visual obstacles or increasing visibility;

Those elements were identified after the descriptions of the conflictions (see page 219), which reflect the reasoning shown in the following table:

Conflict Name	Affected quality				Location		Frequency			Element or condition missing
	T	P	I	A	L	G	M	A	N	
Transient Protection X Lack of canopy in the entrance of shops:	x		x			x	x	x	x	Canopy or other protective element;
Transition between territories X Lack of transitional space in the shops	x	x	x			x	x	x		Transitional areas at shop entrances;
Clear orientation X Lack of hierarchy in the public open space		x	x	x	x		x	x	x	New design and layout for pavement;
Elevated central point to X Lack of defined central point	x		x	x	x		x	x	x	A central point, a monument, sculptures, or fountains;
Resting in public space X Lack of good benches		x		x	x		x	x		Benches;
Shops Supply X Lack of service entrance				x		x	x	x		Urban solution or equivalent to the problem of supplying shops;
Circulation of cars X Lack of defined path to cars				x		x	x	x	x	Pathways for cars;
Identity X Lack of uniqueness			x			x	x	x	x	Shape of the buildings;
Visual signs X Disorder	x		x	x		x	x	x	x	Visual communication ordered;
Private use of urban equipment X	x	x	x		x		x	x	x	Satisfactory layout for urban equipment and furniture;

Lack of defined territory to urban furniture									
Communal Sense in night time X Lack of luminosity	x		x	x		x			x	New Lighting project;
Visibility of street precinct X Visual obstacles			x		x		x	x	x	Cleaning visual obstacles or increasing visibility;

The detailed identification of problems in Fargate Street can be found in the section entitled "Fargate Project: Conflicts Report" on page 217.

b) Conflicts identified by the students

The students were introduced to the framework in the form that had been developed by 9 February 2006. The final submission date for the project was 30 May 2006, when they handed in a multimedia CD-Rom about their project, containing an interactive presentation of plans, sections, 3-dimensional models and texts to justify their solutions. In one of those texts, considered here as the rationale, the students introduced some statements related to the identification of problems in the site. Mainly, they highlighted that:

> "*The shops and retails in the area are normally close in the evenings at around 6 o'clock which makes the local spaces inactive at this time. The city centre in general should be livelier and attract people at this time of the day. Thus, the main aim here would be to make the social activities pursued in the evening at the city centre active by introducing various entertainment based activities.*" *(See page 244).*

Thus, together with the conflicts mentioned in the report, the main problem identified was the lack of vitality that resulted from the absence of activities in the street by evening time. This statement was also a justification to all solutions given, and should be analysed in order to understand the case.

6.3. Solutions

The multimedia produced to present the project contained about 40 different screens, among the still frames with images or animations. All the projects were presented with this resource and some snapshots of those screens are presented in a summarized form in the Appendices, under the title of 'Fargate Project Drawings', on page 245 .

According to the rationale produced by the students, the solutions were intended to provide interactive information relating to Sheffield in general and Fargate in particular. The main idea was to create a landmark in Fargate area that would portray the identity of Sheffield in general and yet highlight the development of modern technology in this area.

A circular Information Kiosk was planned in the corner near the City Hall Building. The kiosk would contain four sectors relating to information about the city of Sheffield, places of interest, its industrial history and also the city council. It would also contain an interactive map in the central

portion which would provide information about directions to various places in Sheffield from the city centre.

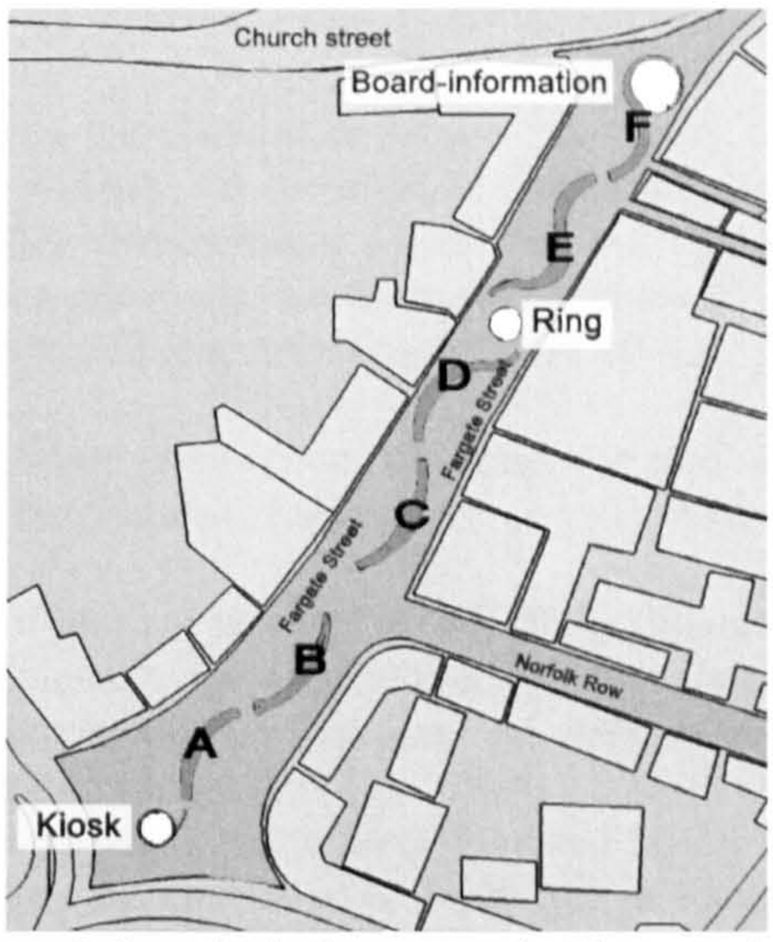

Figure 39: General plan of solutions, snapshot from multimedia screen.

Near Church Street there would be a wall named '*board-information*' which would issue images and data collected in the site. Between those two poles, six panels made of light material, with multimedia resources such as interactive displays, sound and the like were to be created. In front of each building would be presented a panel which would depict information about products, bargains, sales and other utilities related to the shops.

In the central area of this street the wall would give way to what was called the '*3D Photo Capture Ring*', which would comprise 20 cameras located at 30 feet over the ground, all of which would focus on the central area. Taking pictures from each camera at intervals of seconds, the cameras would provide a tri-dimensional view of the central area of the ring, permitting the creation of an archive about the activities taking place in the street. The footage produced in the Ring, consisting of a fly around the central area of the ring, would be exhibited on the info-board through its displays.

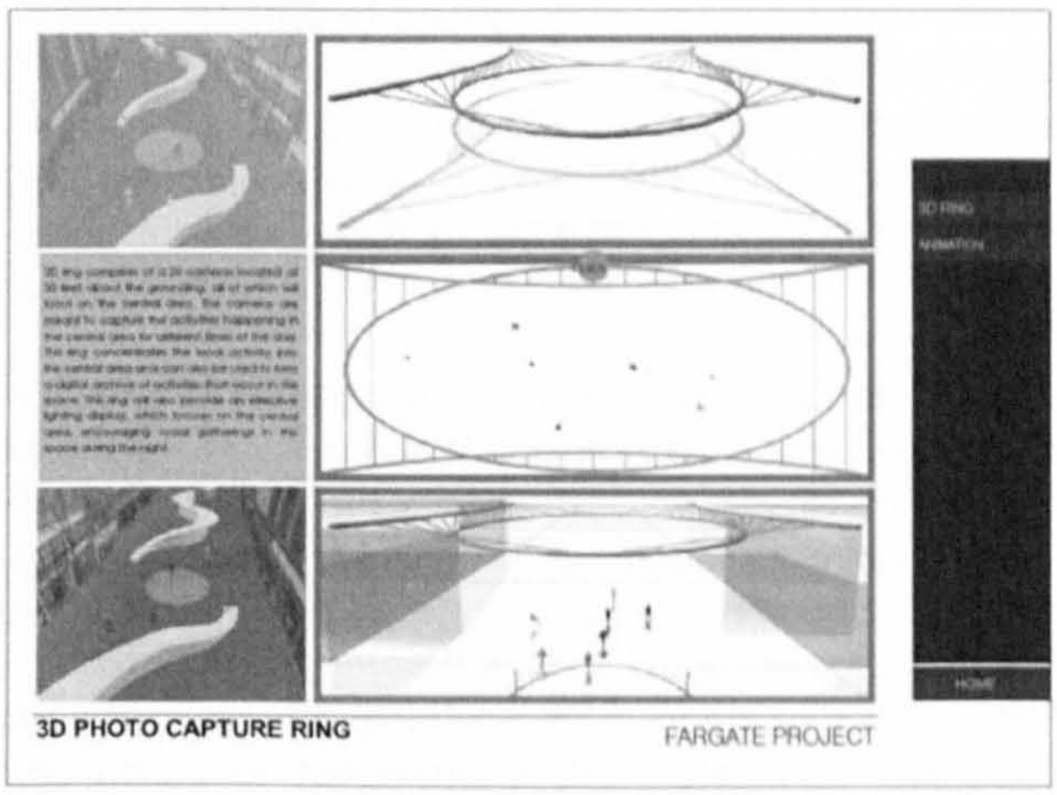

Figure 40: Snapshot of the multimedia presenting the '*3D Photo Capture Ring*'. The text in the figure is readable on page on page 245.

6.4. *Evaluation of the project*

Following the same structure as the Gwangbok Project case study (see section 5.4 on page 119), this section will examine the evidence via the material elaborated during the Fargate Street project produced by the students which demonstrates whether or not that project satisfied the expected outcomes derived from the key questions. To do so, those items of evidence will be described in the same order as the list of expected outcomes (see on page 103).

The Fargate Project, through an analysis of its drawings and rationales, was examined by considering the evidence that the framework had given its users the means to:

1. Explain the qualities of place in terms of Territoriality, Privacy, Identity and Ambience;

As has been commented previously, the aim of this objective is to enable skills in identifying conflicts, and, therefore, to permit the creation of correlations with digital technologies components. However, throughout the whole Fargate Project, there were no direct references to the qualities of place in the form that they were conceptualized in the framework. The references to conflict mentioned in the project are concerned with the lack of identity in Fargate Street only in a indirect way, as, for example, when it was suggested that '*the locals are unable to relate themselves with the space due a lack of an existent landmark in this space*' (see on page 244). In addition this can be regarded as an indirect reference to the qualities where the rationale identifies the main problem to be addressed by the project as the lack of vitality resulting from the absence of activities from the street during evening time.

2. Explain the topology of the elements of place in terms of Centrality, enclosure, internal area, internal directions, and entrances;

This outcome is concerned with the ability to correlate the physical elements of place to its qualities, thus permitting inferences about the specification of digital technologies components in order to reinforce place's qualities. However, there was no evidence of the use of the terminology of elements of place in the project. This was a result of the partial development of the framework at that time, which was yet to introduce such concepts.

3. Given a place, identify the conflicts between spatial elements and activities and elicit how this interfere over the qualities of place;

Regarding the project produced and its rationale it can be said that this objective was only partially achieved since the architects did not properly amend the given report about conflicts, but rather introduced only a main interpretation for a general problem. There is only a reference to the need of a landmark strong enough to relate locals to the place, but this was mentioned without a proper relation to the conceptual framework.

4. Compare types of digital technologies components (to sense, to act, to represent the place);

There is no comparison of digital technologies components according to their function in the place; neither was there evidence that those concepts guided the project. For instance, sensor components such as cameras, which are present in the Photo Capture Ring solution, were not distinguished from among the other components that were to act in the place, such as the screens in the information-board that was to exhibit the images captured by that Ring. As common with other elements, there were no distinctions made between the specified components so as to clarify how they would affect the solution by sensing, acting or representing the place. This was caused by a lack of such conceptual discrimination in the framework as it existed at that time.

5. Explain the topology of digital technologies components and the potential interference of it with the place's qualities (explain the correlations between interiority/exteriority, visibility and appropriation and the functions of the digital technologies components);

This outcome reflects the ability to create relations between the technical functioning of digital technologies components and general spatial principles related to the place's qualities. However, there were no explanations in this sense, despite the fact that some solutions presented were perfectly related to the topology of the components of IT. Those components could be correlated to the position of enclosures and other elements of the place. For instance, the multimedia panels which were to be located in front of the buildings were obviously linked to the location through the visibility of the building (see Figure 41). Furthermore, the building should be visible from the location of the screen; in other words the building, needs to be just as visible as the information about it. However, details of the panels shown a contradiction with this potential correlation, since they suggested a panel design that diminished the visibility of the buildings.

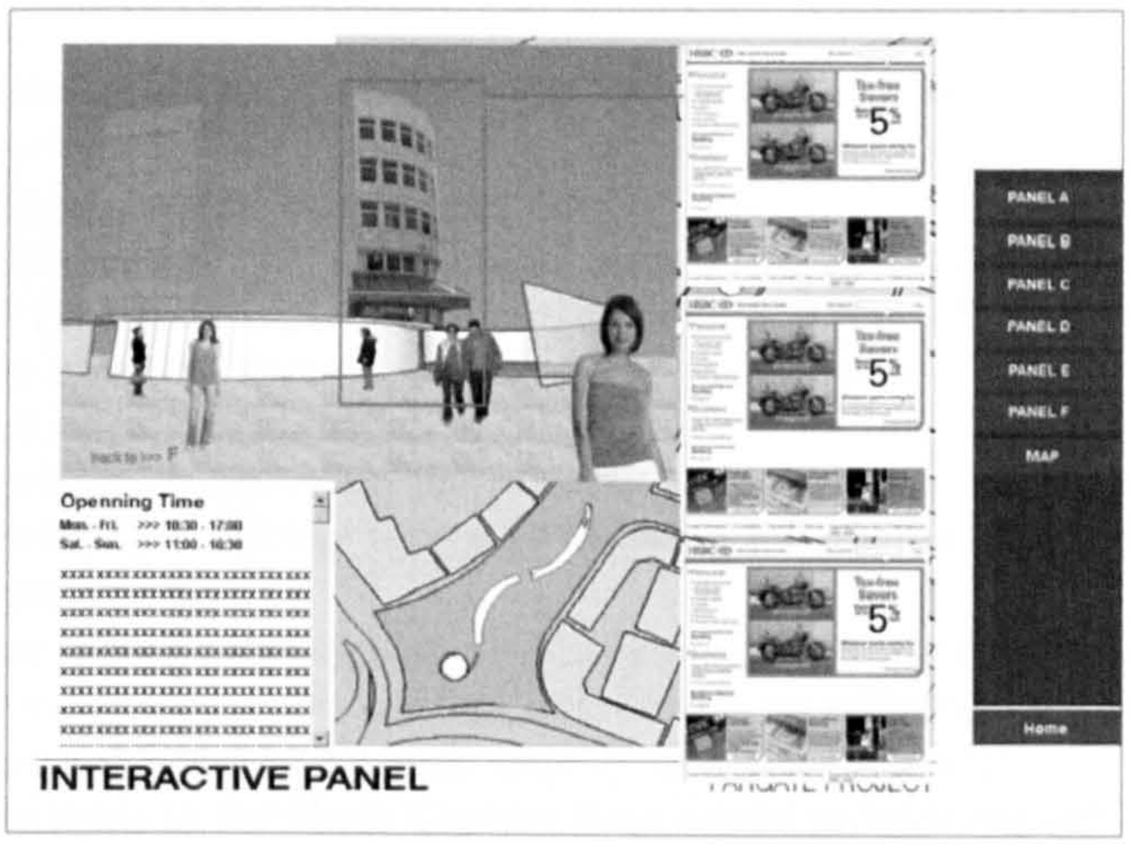

Figure 41: Interactive Panel F, in front of HSBC agency. The red square highlight a proximity of the screen in the panel and the building.

In order to act as an element of place, displays need the visibility given by a position of relative centrality in the internal area of the place, and when it is linked to the place's components, like a part of the surface of the enclosure of the precinct of the street, both surface (façade) referred to and the displays should be visible from that point in the internal area.

This mistake was made with reference to all the interactive panels, suggesting a lack of knowledge about the correlation between the topology of IT and the topology of the place. This was certainly caused by the fact that at the time of Fargate Project, the framework was not sufficiently developed in terms of conceptual scope. As a matter of fact, the problems faced in the solutions to the Fargate Project were a guide to further developments in the theoretical approach.

6. Create solutions to the identified conflicts by using digital technologies components and spatial elements;

By analysing the conflicts enumerated in the report and the solutions provided by Fargate Project, it is now possible to see how many conflicts were resolved by IT usage as proposed by the students:

- Transient Protection X lack of canopy in the entrance of shops:

This conflict was not resolved: the canopy provided protection only to the interactive panel.

- Transition between territories X lack of transitional space in the shops:

Not solved; doors and entrances remained without the referred transitions.

- Clear orientation X lack of hierarchy in the public open space:

The creation of marks in the two extremities of the street (kiosk and info-board) and the distribution of six panels along its internal area can be regarded as an attempt to provide a solution to the lack of hierarchy in that space. However, this solution exacerbated other conflicts.

- Elevated central point X lack of defined central point:

The solution obscured visibility in the public space, creating more conflicts than solutions. With respect to the possibility of getting an idea of the place at a glance, the panels blocked the visibility along the internal area of the street, and it was not clear in the rationale whether the board-information would exhibit images collected from the various points along the street.

- Resting in public space X lack of good benches:

No solutions were given.

- Shops Supply X lack of service entrance:

No solution were given. Again, this conflict was worsened by the solutions that proposed a series of panels dividing the street, since those solutions inhibited the car thoroughfares without marking them on the ground.

- Circulation of cars X lack of defined thoroughfares for cars:

No solutions were given.

- Identity X lack of uniqueness:

This conflict was addressed by creating solutions using IT as attractions for the local public. The panels, the kiosk and the Photo Capture Ring are essentially a way of strengthening local identity by providing a specific means of entertaining, shopping and tourism.

- Visual signs X disorder:

No solutions were mentioned. However, the presence of displays in the interactive panels would permit a more reasonable and efficient means of showing information about the shops, which can be considered a solution.

- Private use of urban equipment X lack of defined territory for urban furniture:

The urban furniture was ignored in the solution, and there is no reference to it in the whole project.

- Communal Sense in the night time X lack of luminosity:

It was claimed that the lights in the Photo Capture Ring would provide enough light.

- Visibility of street precinct X visual obstacles:

The problem was worsened by the introduction of panels.

In conclusion, three of the fifteen conflicts have used IT as a solution to resolve conflicts like the lack of hierarchy in the internal area, identity and visual disorder and signalization. For this reason, this outcome was only partially achieved.

7. Implement the IT solutions as an integrated part of the place's topology;

As was mentioned in section 5.4, this outcome had as its intention the observation of whether or not a solution using IT was physically intrusive by requiring heavy refurbishment to support it. As it has been mentioned, knowledge about IT topology and place topology did not result in any evidence, either in the rationales or the drawings. Thus, the solutions were an intuitive result of the conformation of all the shapes to the dominant directionality of the street. For this reason, this outcome is regarded as having been partially achieved.

8. Justify the use of each IT component in terms of their contributions to the solutions of conflicts, eliciting their influence over topological characteristics such as interiority/exteriority, visibility and appropriation;

There are no evidences of justifications in this sense. As has been mentioned, once again, the framework at that time did not offer the conceptual elements that would permit the achievement of this result.

9. Plan the IT system together with physical interventions that would help to solve the detected conflicts;

The aim of this outcome was to observe how the use of IT has supported general solutions. As has been seen above, only three conflicts can be considered solved by IT usage. Therefore, it is only fair to regard this outcome as having been only partially achieved, regarding the number of conflicts that remained unresolved.

10. Plan physical changes to support the planned IT system;

This outcome considers whether the framework has provided an understanding of the IT systems so as to support the design of spatial features according to the requirements of the technological issues implied by the digital technologies components used. Thus, it is possible to say that this outcome was partially achieved in Fargate Street Project. This means that, despite the design being clearly related to IT application, it still contains some evidence through the analysis of the blueprints that only some general physical supports were provided. For instance, throughout the project it was not possible to find any specification of technical particularities referring to the displays in their placement on the curved surfaces of the interactive panels. The same observation can be made regarding the kiosk, which has rounded walls and internally has curved displays, for which technologies were not specified. For both panels and kiosk, which type of device would gather inputs from people and what would be their physical requirements were not mentioned. Finally, the drawings to represent the Photo Capture Ring do not specify either cameras or lights so as to clarify its function. That blueprint is in fact very schematic, and thus the solutions were without any precision. In conclusion, the evidence points to the fact that there was no integral understanding about the technical specifications of the digital technologies components used, resulting in an inaccurate drawing of physical features to support them.

11. Specifying the spatial requirements for the IT system adopted;

This outcome concerns the ability to provide precise evidence of the understanding of IT component function and how they could be assembled in the space. However, the evidence, such as those provided for the former outcome can be interpreted as a lack of understanding about how some digital technologies components work in the place. For this reason, this outcome was also considered not to have been achieved.

12. Plan schemes of IT systems such as gadgets to be used in the place;

There was not an idea that involved the use of IT as a system to support the solutions. Also, there were no gadgets, such as mobile or wearable IT resources, proposed for the solution provided. All the elements were embedded or supported fixedly at physical points. Communications links, for instance, common in the Ubicomp systems, were mentioned only indirectly in the project by showing WebPages as images on the interactive panels but their functioning in relation to the place and the components were not openly mentioned in the schemes or rationales.

13. Specify the digital technologies components and gadget functions in the system so as to permit exchanges with other fields such as computing sciences;

This outcome was not achieved. There were no sufficient appropriate terminology and accurate specification to permit an intelligible discussion with those involved in other specialized fields.

14. Justify the solutions adopted, clarifying the accomplished advantages;

This outcome was not achieved since the justifications of the solutions were based on a limited *'universe'* of concepts, referring to the establishment of the place by means of creating a landmark by the use of IT. This was probably caused by the lack of proper conceptual development in the framework at the time of the Fargate project.

15. Criticize the solutions designed to feedback the theory.

There are no evidences of critical reflection that would provide feedback to the theory.

rethinking of the set of concepts that considered together ought to provide a reasonable explanation of the phenomenon.

In this research, the initial key questions have generated some hypotheses about the skills that a framework, ideally, should provide architects with when the concern is with giving them support in the design of public urban spaces equipped with Ubicomp systems. Table 22 in on page 103 shows how some hypotheses derived from initial key questions that were related to the development of such a framework and how, in turn, expected outcomes were derived from these hypotheses.

The first conceptual construction was created in order to correlate IT with places, and it was derived from questions that came up in the initial project where IT components were applied as a means to solve conflicts in Gwangbok Street in 2005. That first framework was used by a team of architects in 2006 to support them in the creation of Ubicomp solutions for another public place - the Fargate Project. Now that, as can be seen in the previous section, a theoretical test has been made via the observation of whether or not the initial expected outcomes were achieved in both projects.

In comparison with the Gwangbok Project, where 8 of the 15 expected outcomes have been achieved, the Fargate Project only partially achieved 5. An initial conclusion, therefore, would be that the developed framework was not satisfactory means of assisting architects in their projects. However, this affirmation requires better reasoning, since there was no framework at the time of the Gwangbok Project. The results of the analysis of the outcomes revealed that, for the Fargate Project, some concepts were missing or required further development. The formulation of expected outcomes was made possible only after the Gwangbok Project. Those outcomes have made it possible to observe precisely where, inside the developing theory, there were missing concepts and what they were for. Therefore, a better understanding of that situation can be achieved by paying attention to the systematic efforts of developing the theory via the study of those cases.

By analysing the appendices on page 238), together with Chapter 1, some conclusion can be drawn. It can be seen that, in the first attempt to develop a framework, the starting point was the discussion of the relationship between information and space. After linking information with the social world, the way that society uses technology to deal with the handling of information leads to another general discussion, which was concerned with the relations between society and technology. In an attempt to understand that former duality, it was adopted as an idea by Don Ihde (1990) who gave a rich and subtle account of the variety and complexity of the relationship between people and technology. Different relations between people, technology and the ideas about the world were characterized by that author. It was thought that, by the time of the Fargate project, the inclusion of those approaches within the scope of the framework would help the architects to reflect on the potential correlations between digital technologies components and identified conflicts. Therefore, it was supposed that that reflection would guide the architects in the creation of appropriate solutions using digital technologies components in a given place.

Ihde (1990) mentions that the relation between human and technology could basically be explained in four ways, which he named as follows: embodiment relations, hermeneutic relations, alterity relations and '*backgrounded*' relations. Embodiment relations happen when humans adopt technology as a medium to modify and improve their perception of the world. Using glasses to see others or using a telescope to explore the moon are some examples of such relations. Hermeneutic relations correspond to the way people use technology to provide evidence about the world, and those items of evidence are then interpreted inside a structure of conventions. For example, the understanding of a map or the interpretation of an x-ray picture are both examples of hermeneutics relations. The third type of human/technology relations Ihde calls '*alterity*' relations. These correspond to the logic provided by the context of some technologies that present themselves as a world of their own, such as servomechanisms, robots or other appliances that have '*Artificial*

Intelligence'. A fourth type of human/technology relation is referred to by Idhe as '*backgrounded*' relations. These correspond to situations in which the technology recedes into the background of the consciousness of users, such as is the case in automatic central heating systems, traffic control systems, and the like. According to Idhe (1990) these systems are '*black-boxed*' in such a way that people do not attend to them yet they draw on them for their ongoing everyday existence.

During the Fargate Street Project, it was considered that the human/technology relations mentioned by Idhe could be related to the place in order to guide the application of IT components in urban design. Thus, including Idhe classifications of relations between humans and technology, the framework, at that time, was limited to offering his concepts to the architects together with the technique for identifying conflicts. It was expected that the architects, using the concepts provided, could create correlations between the IT components and the place by thinking in terms of the four types of possible relations between humans and technology.

That meant an effort to find out how those relations (embodied, hermeneutics, alterity and back grounded) could be related to the place in terms of its essential characteristics, as external/internal definitions, its visibility terms, and its appropriateness to human purposes, was required. For instance, the architects could think about solving conflicts affecting the identity of place by creating an embodiment relation with a gadget that would permit augmentation of the information about the characteristics of the physical elements in the interior of the place, providing multimedia content, through the use of a head set or special glasses. In all cases, those relations would modify the perception of the place by providing wearable gadgets or other types of components which would interact directly with the bodies of the users. The concept of hermeneutic relations was thought of, for example, as being able to stimulate the conception of solutions by using the structural interpretations of signals resulting from characteristics collected in the place, such as, for instance, those referring to the composition of a local map in a screen display, showing its shops, landmarks, etc, in order to provide solutions to problems related to the lack of a hierarchy in a place and path finding. Other examples of solutions using the relations of alterity could be developed by using gadgets interaction with which would permit engagement with a new logic of place, such as the creation of virtual characters associated with buildings in a virtual and interactive representation of the street. Finally, 'back grounded' relations could inspire, for instance, the creation of retractile canopies automatically controlled in order to minimise the perception of a lack of that element in the street itself.

However, the project results did not show any evidence that the expected use of concepts had taken place. Quite the opposite in fact: it presented the somewhat '*skimpy*' use of concepts in the justifications to the solutions, and the method of identification of conflicts could be interpreted as being irrelevant to the creation of solutions. It was clear that the structural organization of the framework was not offering a connection between concepts and methods to solve identified problems.

Following the analysis of the results of the Fargate project as presented above, the place-theoretical framework was further developed in two important steps. The first was an elaboration of a general classification of digital technologies components in terms of their functions in relation to place. Thus, the components, such as sensors, microprocessors, displays, servomechanisms, controllers, software and so on would be understood in relation to three functions: digital technologies components to sense the place, to act in the place and to represent the place.

The second develolment was concerned with systematically investigating the correlations between each IT component and the place. This required the creation of a taxonomy regarding *the topology of place elements*. Those topological elements were represented by the topology of those constant phenomena (events) perceived in the place, comprising categories such as *enclosures, internal areas, centrality, directions, and entrances*.

All those developments were aimed at providing a clear reasoning about the use of IT in urban space so as to reinforce the qualities of place. They can actually be understood as being a theoretical mediation between abstracts concepts related to the quality of place and the concrete ways of using digital technologies components to potentially solve identified problems interfering with those qualities. However, it was clear that the provision of the architects with a list of conflicts prior to the commencement of the project was not as effective engaging them in reasoning about spatial problems with the proposed space reading method. Thus, with the third case study, a prior report on spatial conflicts was not handed out, and the architects were given only an account of general problems relating to the chosen site, as will be seen in the next chapter.

Chapter 7:
Case III: Campus of The University of Sheffield

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Case III: Campus of the University of Sheffield

A new opportunity to observe a project resulting from the use of the refined framework by architects arose once from the "*Interactive Urban Visualisation Modelling*" module from Sheffield University's the Master's Course in Architecture, this time during the spring semester of 2007. The course tutor kindly agreed to the inclusion of an exercise that allowed for the observation of the use of the framework by the architects in a project addressing a hypothetical project of urban recasting using digital technologies components.

Two working groups of four architect students were asked to use the place-theoretical framework to support the elaboration of a project using Ubicomp to resolve the spatial conflicts identified in an area of the university campus. At this time, the architects were asked to identify the conflicts by using the technique known as "*reading space*". As can be seen on page 264, the proposed exercise was based on the hypotheses that an initiative to improve the current state of the Concourse space located in the central area of the campus was launched jointly by the University of Sheffield and a telecommunications company specializing in locative media technologies. The initiative called for a proposal for a campus space improvement scheme that would utilize Ubiquitous computing. In the exercise, Ubicomp was referred to as 'digital augmentation', and it was defined as an act of developing and deploying appropriate IT components to resolve spatial deficiencies and conflicts identified in an area.

Thus, the architects were invited to submit a design proposal, specifying how IT elements might be used and which physical changes would be required to invigorate the Concourse space. With its completion, the revision of the framework permitted the formulation of educational outcomes in a concise manner, since the structural sequences of the framework were more clearly connected in terms of objective procedures. The Bloom's taxonomy (1956) was used, and thus, both an initial design for the exercise, as is shown on page 262 and a diagram drawn up in terms of the educational outcomes expected were obtained (the bold italic emphasis were in the original):

(1) After the exercise the student should have ***an Understanding of structure of places***; that means, s/he should understand the theoretical assumptions, being able to define concepts as Architectural attributes (to dwelling), qualities of place (TPIA), Topology of the components of place (*Centrality, enclosure, internal area, internal directions, entrances*);

(2) After the exercise the student should have an ***Understanding of digital technologies components***; that means, s/he should be able to recognize different types of digital technologies

components, analyse their topology according to the framework presented and analyse the potential interference over place's qualities;

(3) After the exercise the student should be able to ***analyse places*** with the concepts given by the proposed framework, meaning that:

S/He should be able to Detect Conflicts between activities and spatial elements in a given place;
And should be able to interpret the conflicts detected as communication interferences over the qualities of the place;

(4) The student should be able to ***synthesize solutions by:***

Planning the IT system of components that will help to solve the detected problems;
Designing physical changes to support the IT system planned;
Designing schemes of IT systems applied and specifying their functionality;

(5) Finally, the student should be able to ***present the project, elucidating by graphical representations the new scenarios*** that come associated with the use of digital technologies components to solve conflicts in the place.

However, in order to simplify the hand-out given to students, the text introducing the exercise was reduced, as is shown in the outline of the course reproduced on page 264. The statements of the outcomes were transformed into sentences asking the students to create definitions for:

(1) How the campus space and its activities could be better supported by a Strategic Digital Augmentation Plan; and
(2) What Physical Modifications would be needed in the area to implement the strategic Digital Augmentation Plan;

It was also made clear to the architects that no specific presentation format was required but the outline design proposal should contain the following information:

(1) The Spatial Deficiencies/Conflicts in the campus area;
(2) A Strategic Outline Design for Digital Augmentation in response to the spatial conflicts identified;
(3) Detailed Design of the Digital Augmentation Components;
(4) Illustrations conveying the new spatial experiences engendered by the digital augmentation scheme.

The period for the development of the project by the architects students was from 16 February to 29 May 2007. Review sessions with the tutor and myself were planned timetabled and in accordance with the outline (see on page 264) they were as follows:
09 March 2007: Group Project Review discussing the Spatial Deficiencies, the Conflicts Analysis, drawing up an Initial Strategy;
16 March 2007: Group Project Review 2, focusing on the Detail of the Strategic Digital Augmentation Plan and its Components;
27 April 2007: Group Project Review 3 focusing on the Detail of the Design of the Digital Augmentation Components;
11 May 2007: Group Project Review 4 finalizing the discussions, from the Details back to the main Strategy adopted in the plans.

By summarizing the previous results obtained through the analysis of the Fargate Project, the following table is able reflect the outcomes achieved:

Expected outcome according to the key questions	**Observed outcome**	**Description of the evidence observed in the drawings and in the rationale**
1. Explaining qualities of place.	Not achieved	There were not direct references to the concepts about place.
2. Explaining topology of elements of place.	Not achieved	There were not evidences of the use of the terminology of elements of place in the project.
3. Identifying of conflicts.	Partially achieved	Few amended conflicts were carried out by the architects as a unique general problem.
4. Comparing types of IT components.	Not achieved	There was not comparison of components of IT accordingly with their function.
5. Explaining topology of IT components.	Not achieved	There were not explanations in this sense.
6. Creating solutions with IT.	Partially achieved	Only two conflicts were integrally and other was partially solved.
7. Creating solutions Integrated in the place.	Partially achieved	The solutions were intuitive, resulting in the conformation of all the shapes, even the dominant directionality of the street.
8. Justifying the use of IT.	Not achieved	There were not evidences of the justifications in this sense.
9. Planning a system of IT	Partially achieved	Physical supports, together with IT in the Interactive panels, supplied Identity. This situation was the unique quality regarded by the solutions.
10. Planning physical supports to IT components.	Partially achieved	Only general solutions; there were no specifications of accurate physical features related to the technology used.
11. Specifying spatial requirements to IT.	Not achieved	There were no specifications of spatial issues relating with IT requirements.
12. Elaborating schemes of IT systems.	Not achieved	There were no gadgets nor mobile resources.
13. Specifying technically IT components.	Not achieved	There was a lack of appropriate terminology and accurate specifications.
14. Justifying the solutions in terms of advantages.	Not achieved	Justifications were based in a limited "universe" of concepts, referring to the implementation of landmark with IT.
15. Feedbacking to theory.	Not achieved	There were no evidences of that.

Table 24: Outcomes achieved in the Fargate Street Project.

6.5. Framework amendments

As was explained in section 4.4.3 on page 90), the case study method can provide improvements to a theory that is being tested. This test consists, firstly, of using the theory to observe a determined phenomenon, and secondly, comparing that phenomenon in its final state with predictions made about it in accordance with the theory. Therefore, this comparison will permit us to observe how strong the theory is, as a conceptual construction that is able to provide explanations. It would also permit the observation of which concepts inside the theory were not able to contribute to the understanding of the phenomenon in focus. The improvement would thus be concerned with the

7.1. The Urban place

The site chosen for the exercise was the central area of the University of Sheffield campus, situated to the west of the city centre, as shown in the Figure 42.

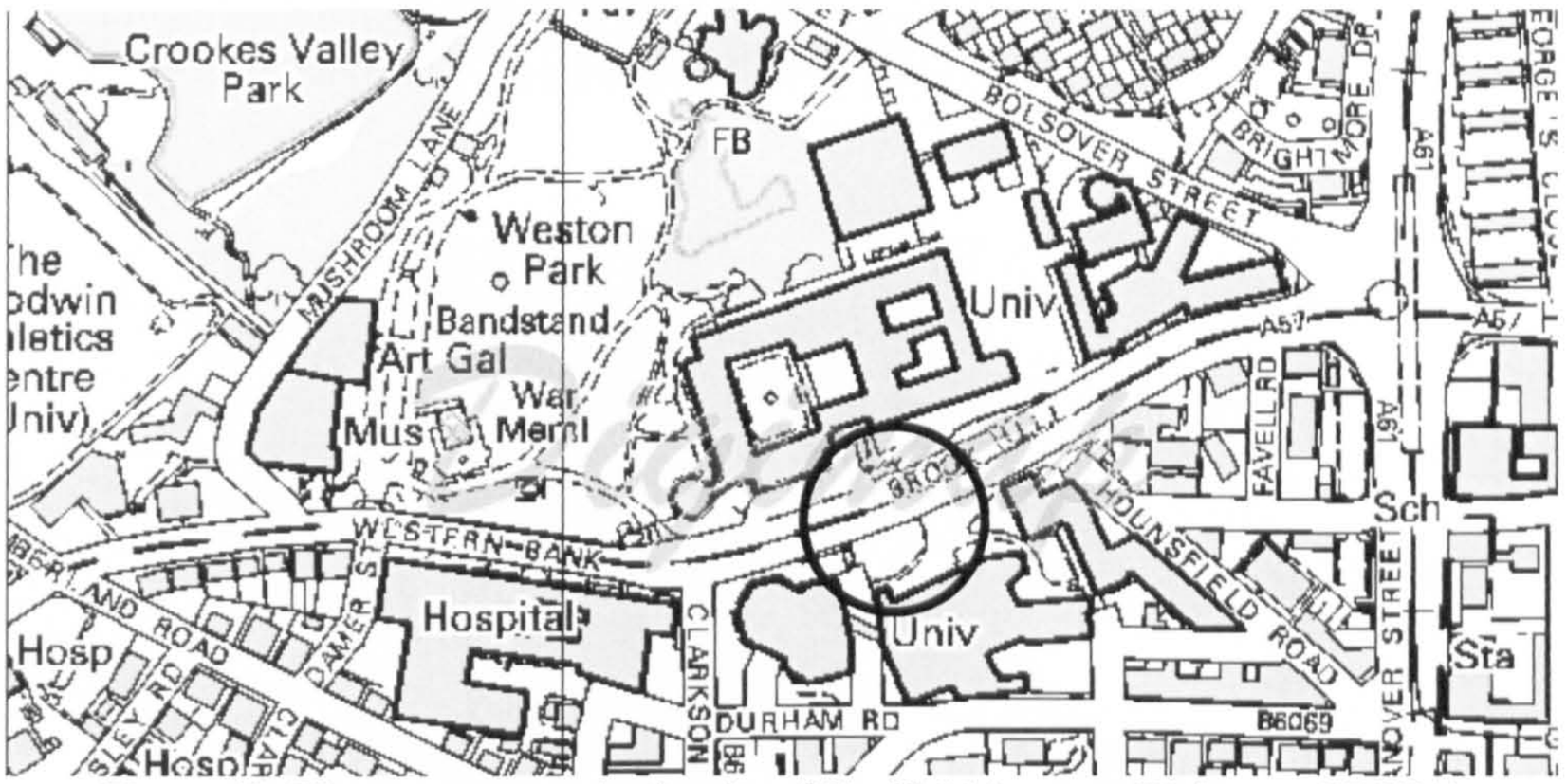


Figure 42: The campus area in the city of Sheffield (source: Digimap - EDINA)

That area corresponds to the area between the *Union of the Students Building* and the *Alfred Denny Buildings* on the University of Sheffield campus at Western Bank. The area is currently divided by a concourse bridge which supports a segment of the Western Bank road.

The students were given the option to interpret freely the limits of the area they would select for the augmentation, inside the grey shaded space in the following map:

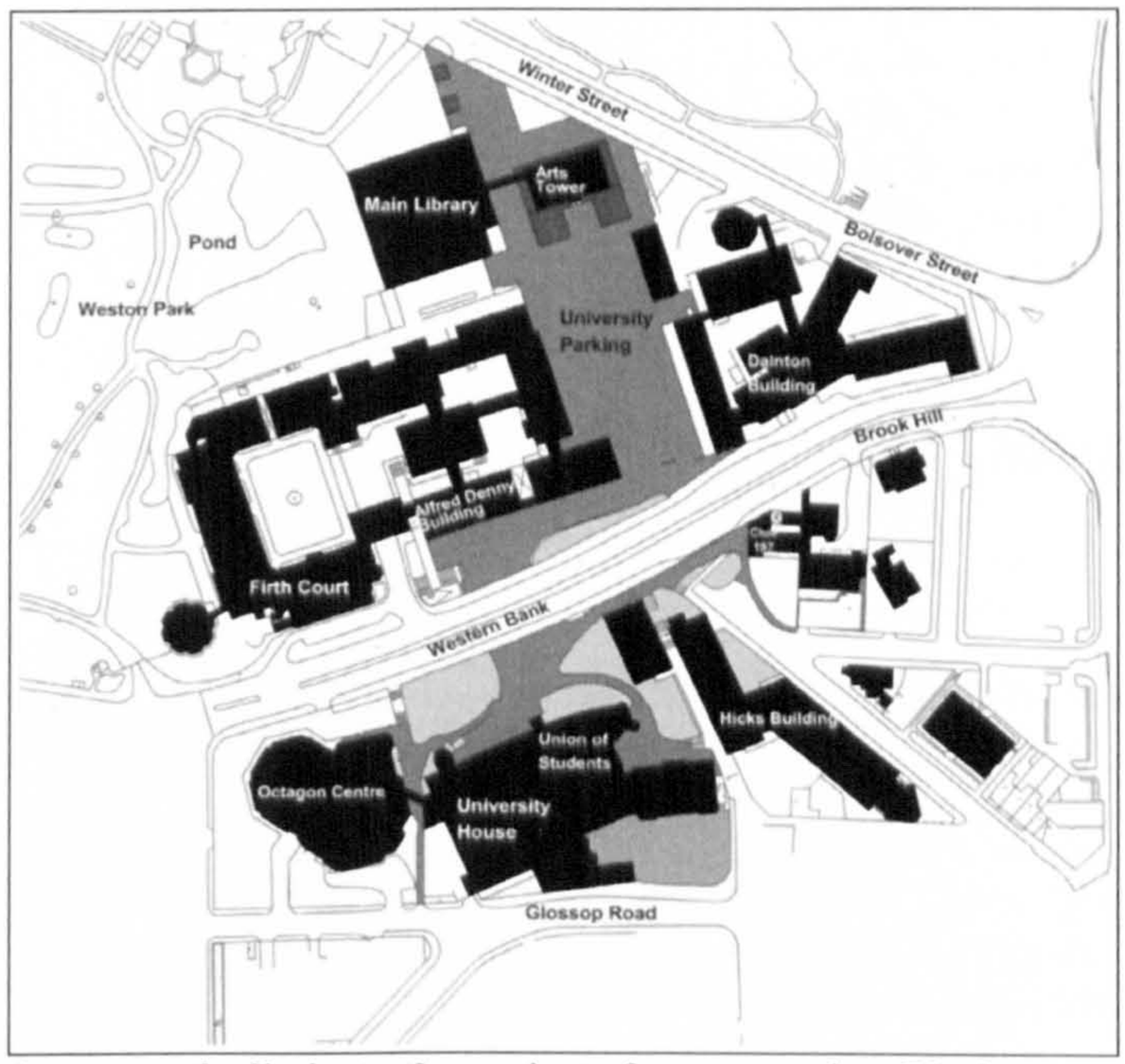


Figure 43: Greyed areas as the limits to the project of augmentation. Black areas are the buildings.

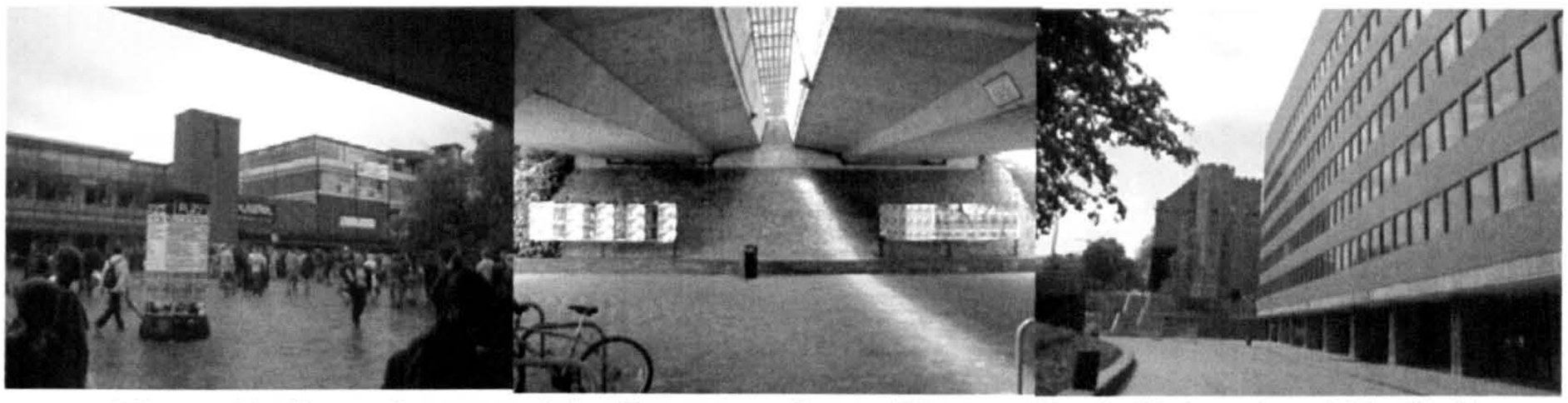


Figure 44: General aspect of the Concourse Space, Western Bank, University of Sheffield

Figure 45: General aspect of the Concourse Space, Western Bank, University of Sheffield

In contrast to the Fargate Project, the architects were not given a report containing a list of identified conflicts for the Campus Project. Instead, they were provided with a hand-out describing the existence of general spatial problems affecting the place's qualities. Thus, it was suggested, once again, that the architects should enrich that initial set of questions with their own direct observations of the site, identifying conflicts in the area using the method known as 'reading spaces' (see General aspect of the Concourse Space, Western Bank, University of Sheffield). Thus, this section will present three views of the problems identified in the area. The first concerns the general view explained to the groups, and the other two, to each group's individual view.

7.2. General problems

The general description of spatial problems as presented in the outline course hand-out (see on page 264) given to the architects was as follows,):

- *"There are not spatial delimitations in the territory of the target area and it probably causes problems in people's orientation, also originating difficulties in the occupation by distinct social groups. It follows that, unsuccessfully, groups try to appropriate the space but their presence is not as frequent as to print an identity over the place;*

- *Various entrances to the buildings and many others options of paths and walkways surround and cross the area, reinforcing its character of temporary flux and transient permanency of people.*

- *The lack of an identifiable central point and a clear hierarchy in the exteriors also contribute to this situation, resulting in an undefined territory which sometimes is crowded by people but frequently is deserted (see Figure 44). This situation leads to an increasing need of surveillance.*

- *Physical transitions from the interiors to the exterior are made difficult as a result of the protection against the cold weather and the shape of the buildings, which do not have habitable and suitable spaces to create transitional spaces to shelter diverse social activities as chatting, gathering and so on. The existent transitions regard only to functional circulation.*

- *In the ground floor at the level of the external area near to the concourse bridge, the visual connections between interiors and exteriors are also rare and poor, resulting in isolation of those sides, contributing to weaken even more the continuity within them."*

7.2.1. Problems identified by group I

Group I considered the area of the site as it is shown in the Figure 46.

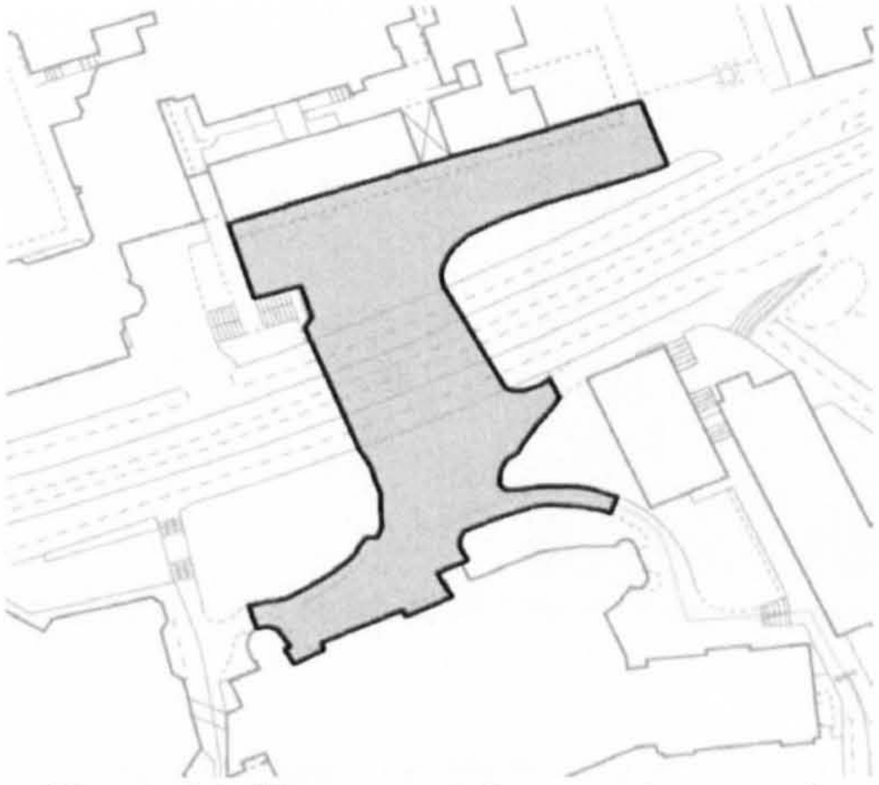


Figure 46: Site area at Campus to group I.

There are six main conflicts identified by group I in that place, and they can be seen in the original rationale on page 267. Those conflicts are compiled and shown as follows:

- *"The Concourse Bridge – The concourse bridge divides the two spaces either side and has created a space beneath it that is dark and uninviting although it does provide shelter and a small amount of seating but this doesn't encourage passers by to linger for any period of time. There is a distinct lack of seating under the concourse with no attraction to spend any prolonged period of time there.*

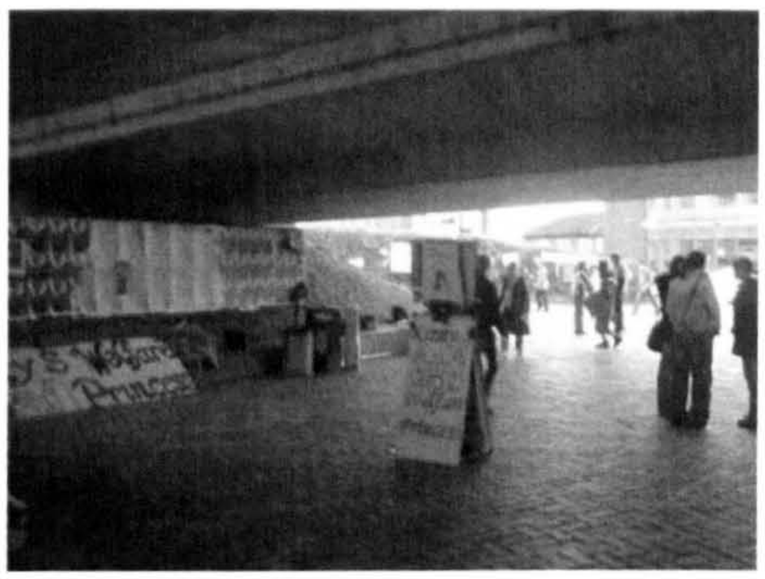


Figure 47: Under the concourse Bridge.

- *Flyering / Flypostering - as the space has a high turnover of people and is on a main route on campus it is no surprise that if any promotion is to be done it will happen here. The problem of Flyering is an annoyance in the space with the traveller or even people sitting down occupying the space being constantly harassed by people promoting the "new club night/film/shampoo etc" - to most people this is a nuisance. This combined with the illegible (fly)posters on throughout the space makes it a not very attractive place to spend any degree of time in. The augmentation of the space will have to deal with these problems and set up a cohesive system to promote events merging Flyering and Flypostering.*

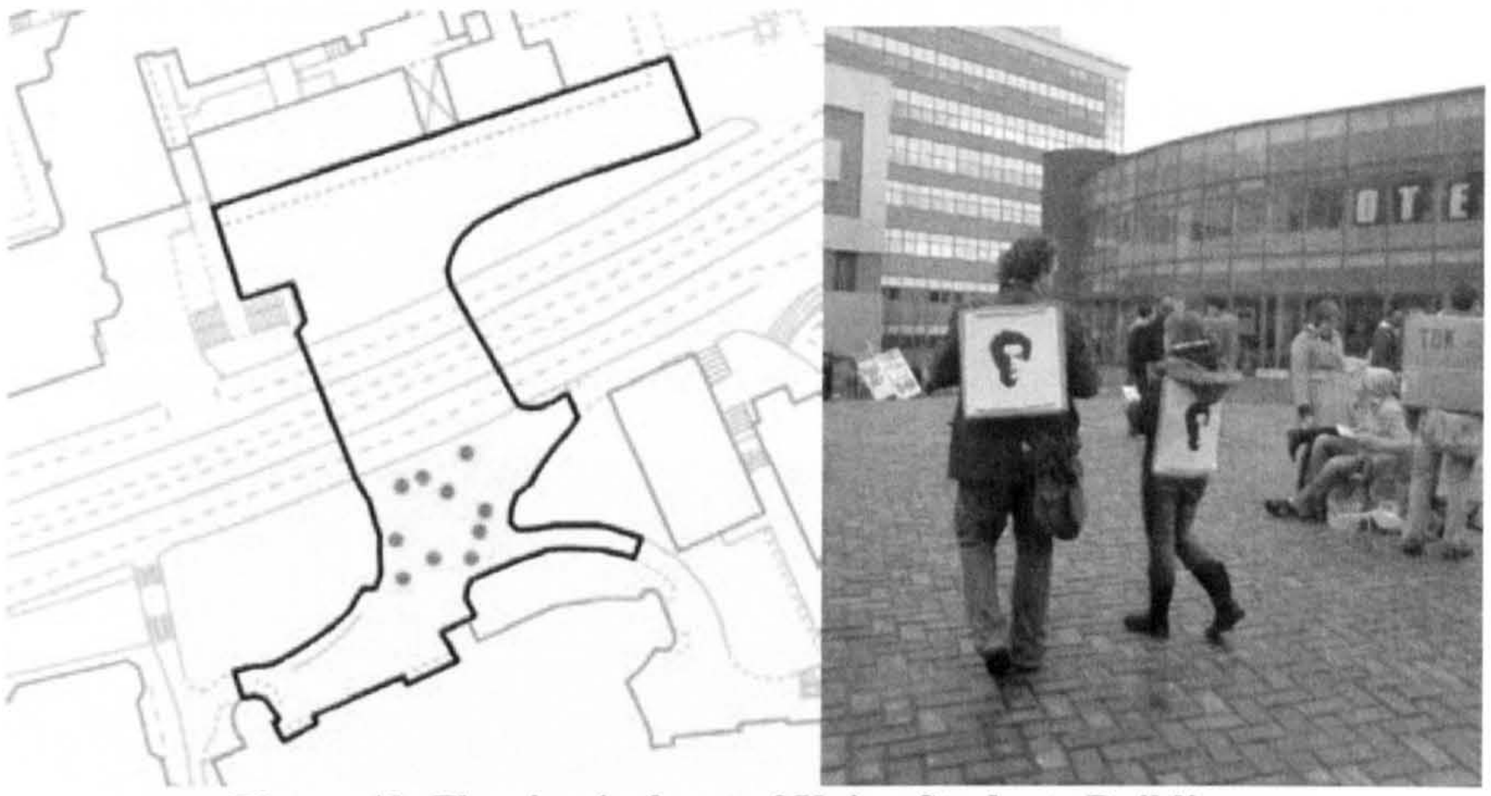


Figure 48: Flyering in front of Union Students Building.

- *Social Space – social spaces are badly needed in the areas to encourage people to spend time there. Currently there is very little seating in the spaces and the shelter of the concourse bridge is not being exploited to it full affect on rainy days. More seating must be provided in the spaces especially under the concourse bridge.*

Figure 49: Bike racks under the concourse bridge at Campus site.

- *Location of the Bike Racks – under the concourse there are several bike racks – as shown in photograph where it is a good idea to have the bike racks in a sheltered area here they obstruct main routes through the site and also encourage people to cycle through the space thus creating another hazard to be dodged/avoided. In the augmentation of this space we believe if the bike racks were spread out towards the entrances exits the space currently used could be put to better use.*

- *Alfred Denny Building – the Alfred Denny Building is situated on the opposite side of the space to the Students Union Building but has neither the life (people outside) or amenities of the Students Union building thus creates a one sided space with everyone travelling across the space towards the union. The faceless, reflective glass wall at ground level could be augmented to achieve a more balanced space with some amenities shared between the buildings e.g. – coffee shop."*

Figure 50: Alfred Denny Building and surroundings.

Finally, a table of conflicts can be summarized from those descriptions as it follows:

Conflict Name	Affected quality				Element or condition missing
	T	P	I	A	
1 – Flyover The space beneath the flyover is dark and	x		x		Lack of informal seating; Lack of interaction between

uninviting. Provides shelter but does not encourage passers by to linger. Also divides the spaces on either side					both sides of the space.
2 – Flypostering Posting of bills underneath flyover.			x	x	Lack of cohesive system to promote events to go alongside flypostering.
3 – Fyering People handing outflyers outside union building and around flyover.		x		x	Lack of a cohesive system to promote events.
4 – Social facilities People are not encouraged to stop and socialize. The area perhaps suffers from having numerous entrances and exits.	x		x	x	Lack of informal seating. A café at ground level of the Stoddard building would create a more cohesive "square".
5 – Bikes Bike racks underneath flyover.	x		x	x	Bike racks could be removed and dispersed to entrances to clear central area.
6 – Blank wall of Stoddard building Faceless, reflective glass wall without activity at ground level.	x		x	x	Amenity ground floor of Stoddard building (e.g. Café).

Table 25: Conflicts identified in Campus site by Group I.

7.2.2. Problems identified by group II

Assuming the limits of the area of the project to be as shown in Figure 51 below, Group II identified 10 conflicts which are compiled on Table 26. There were no accurate descriptions of those conflicts except the summarization shown inside the table. All those conflicts were organized with illustrative pictures supporting their descriptions, as it can be seen on page 295.

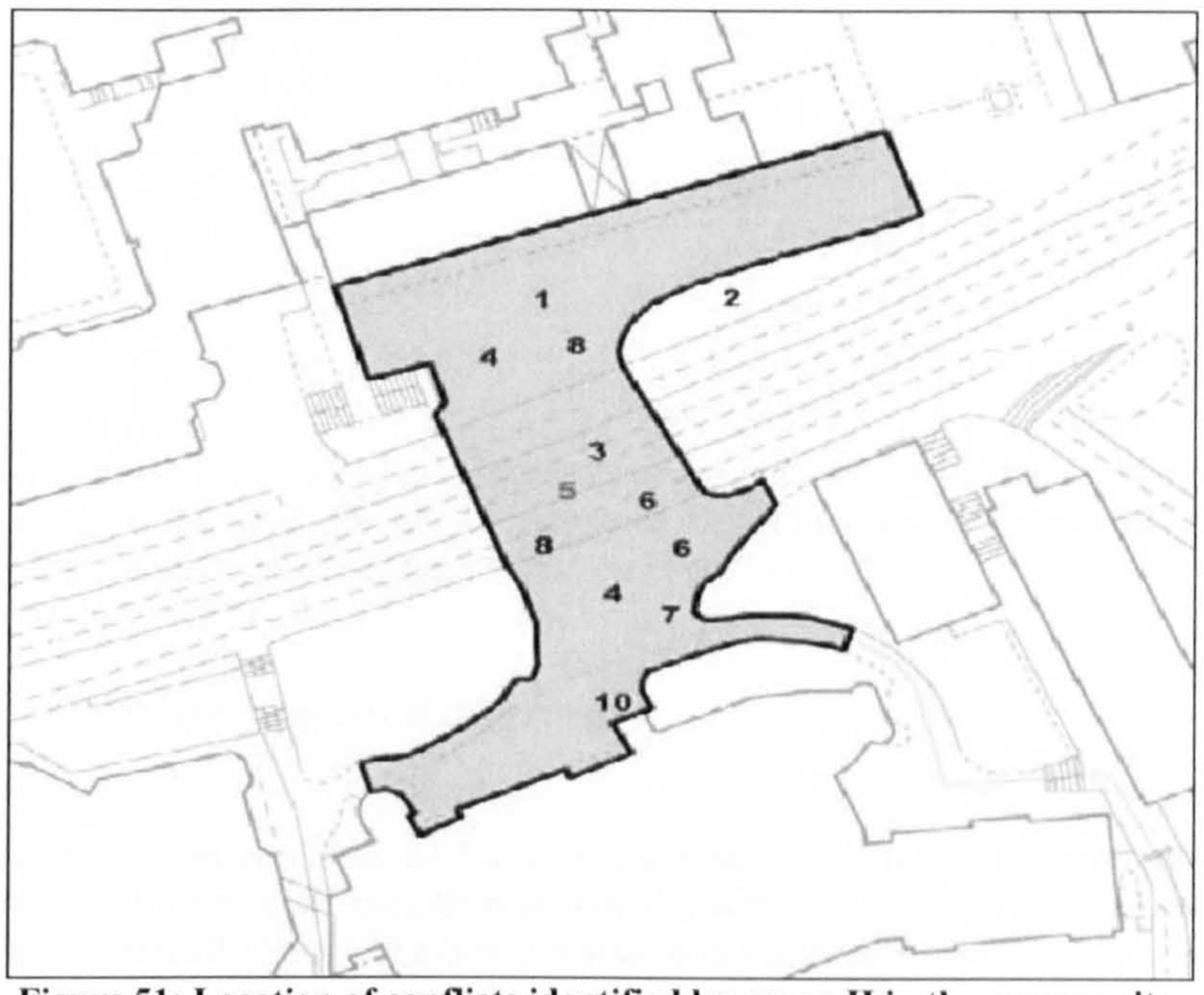


Figure 51: Location of conflicts identified by group II in the campus site.

Legend: T: territoriality; P: Privacy; I: Identity; A: Ambience.

Conflict Name	Affected quality				Element or condition missing
	T	P	I	A	
1 - Movement Patterns Lack of distinct movement zones results in a chaotic impression of random human passage.	x		x	x	Non existent route markers along the route.
2 – Uninviting Soft landscaping areas The landscaped zones fall short of serving as a force of attraction for passers by.	x	x	x	x	Lack of seating/reclining areas, restrictive border design.
3 – Weak sense of place under the overpass This area is left Drab and uninspired, it serves a purely utilitarian purpose.	x	x	x	x	Lacks a strong visual and spatial reference.
4 – Inadequate signage Signage is inconspicuous and thus hardly noticed.			x	x	Bold signage establishing a sense of place and direction.
5 – Underutilization of space Inappropriate use of space under the overpass.	x		x	x	Bold use of space design that grants the space a sense of place.
6 – Lighting Levels Dark zone shuts out the opportunity for visual exploration.	x			x	Creating a brighter ambience for the zone or utilizing the dark area in a positive and creative manner.
7 – Isolated Zones Bereft of human presence or interaction.	x	x		x	Requires activity fostering human socialization.
8- Nocturnal safety of passers by The area remains desert by night.	x		x	x	Lighting strategy, security measures, nocturnal use of the zone.
9 – Flyer distribution People handling leaflets outside the union students building.		x		x	There lacks a cohesive system to promote events and disseminate information
10- Blank façade of the Stoddard building Bare façade. Sparse human activity at the ground level.	x		x	x	Responsive design features on the façades. Amenities to foster diverse activity.

Table 26: Conflicts identified in the Campus site by group II.

7.3. Solutions

This subsection is divided in two parts according to the solutions provided by the two groups of architects. The following texts are comments extracted from the texts provided in the project rationales, reproduced on page 267 (group I) and on page 295 (group II).

7.3.1. Solutions proposed by group I

The first solution was proposed to be built in the space underneath the overpass, and it was basically composed of a set of IT gadgets that would enable an interactive game projection on the ground, walls and eventually on a white board installed in the place itself.

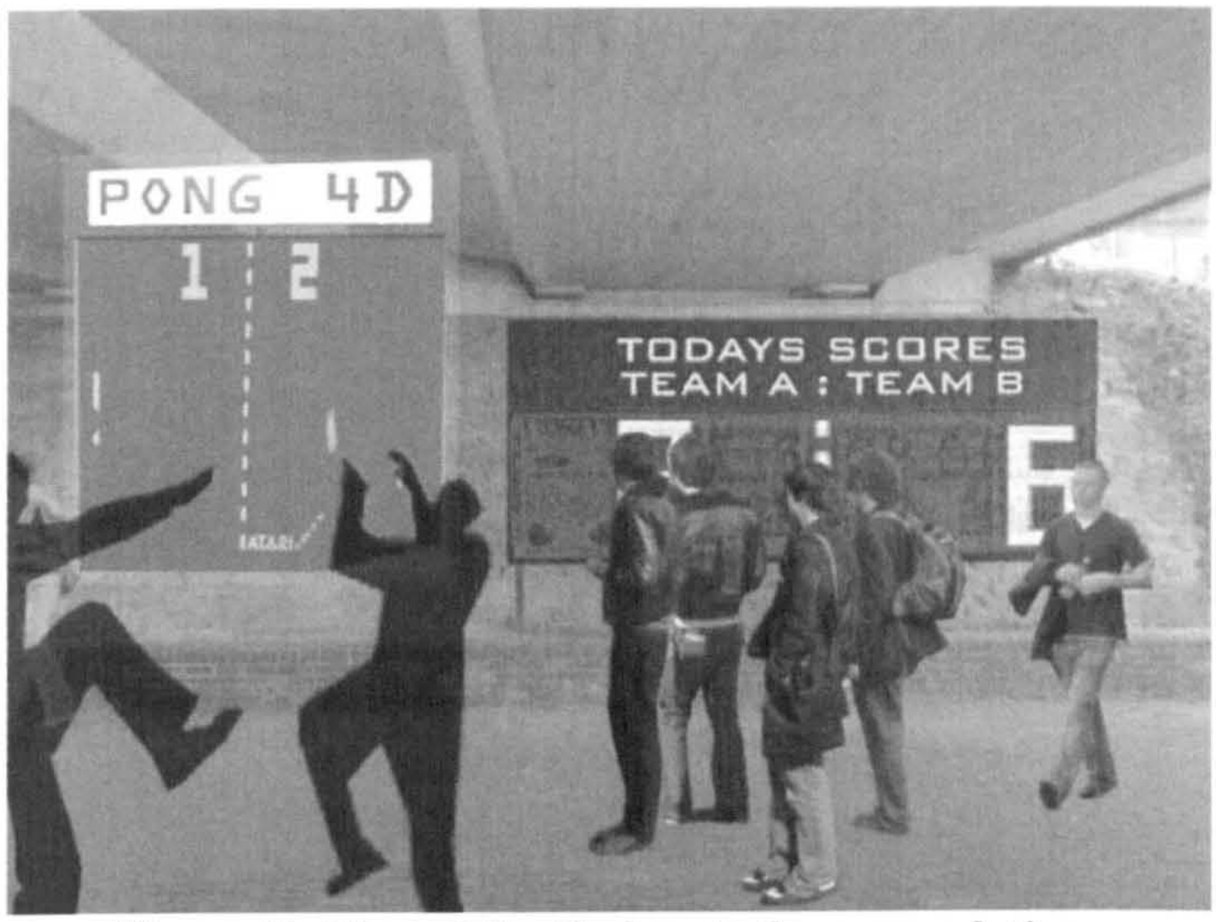


Figure 52: View of the displays to the game solution.

Projectors strategically placed over the paths would draw graphic elements with lights which would be able interact with the players' movements through sensing their positions, modifying, moving, and changing the light shapes and colours.

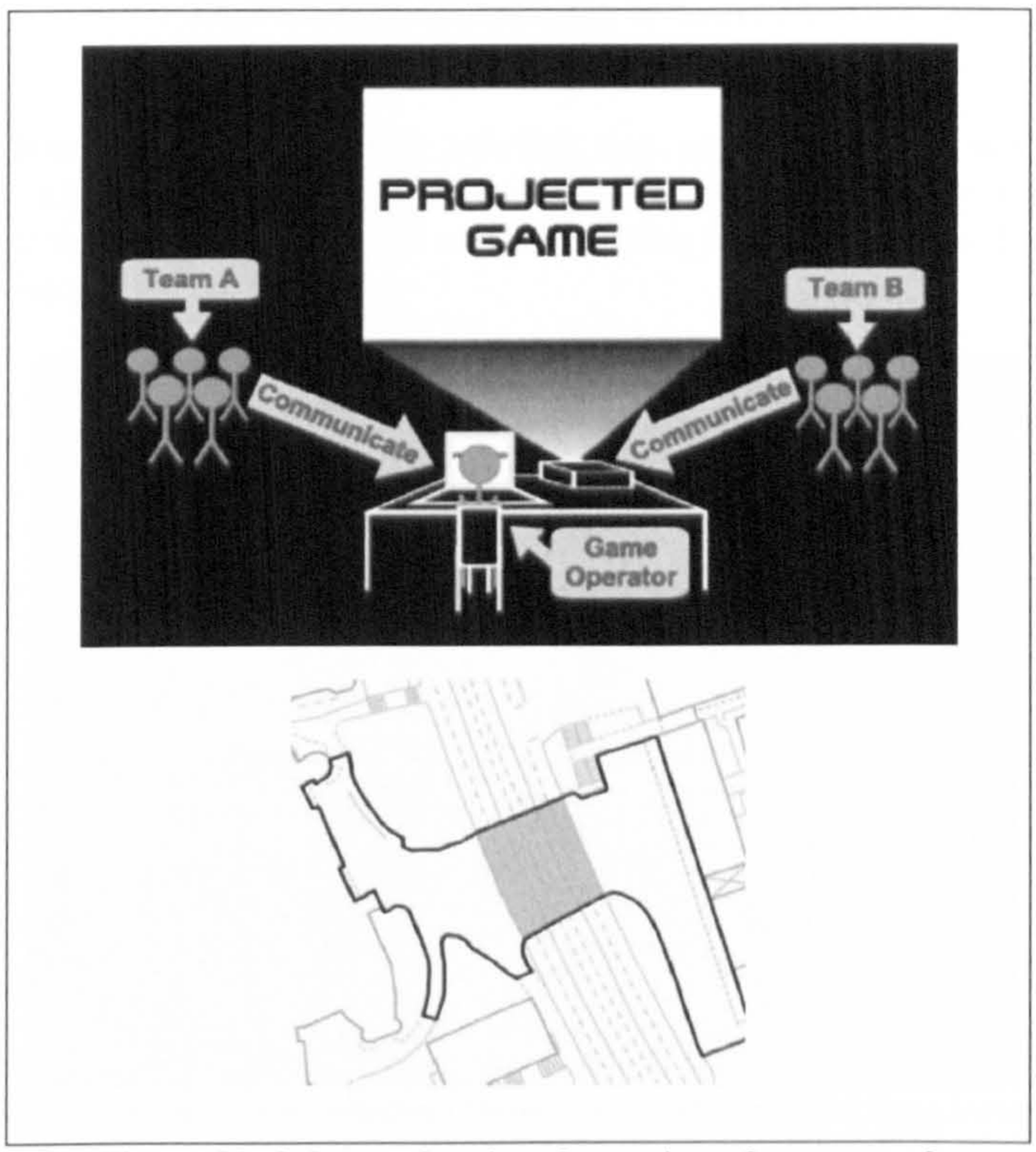


Figure 53: Scheme showing the projected games and the interactions between players and the game operator. The green area is where the projections will take place.

The games would be controlled by a server offering diverse games and customised options to the players. Organized or spontaneous groups of pedestrians could play in teams. It was suggested in

the drawings that the area defined by the two sides underneath the overpass would be used as the 'playing field', with screens displaying the results of the games.

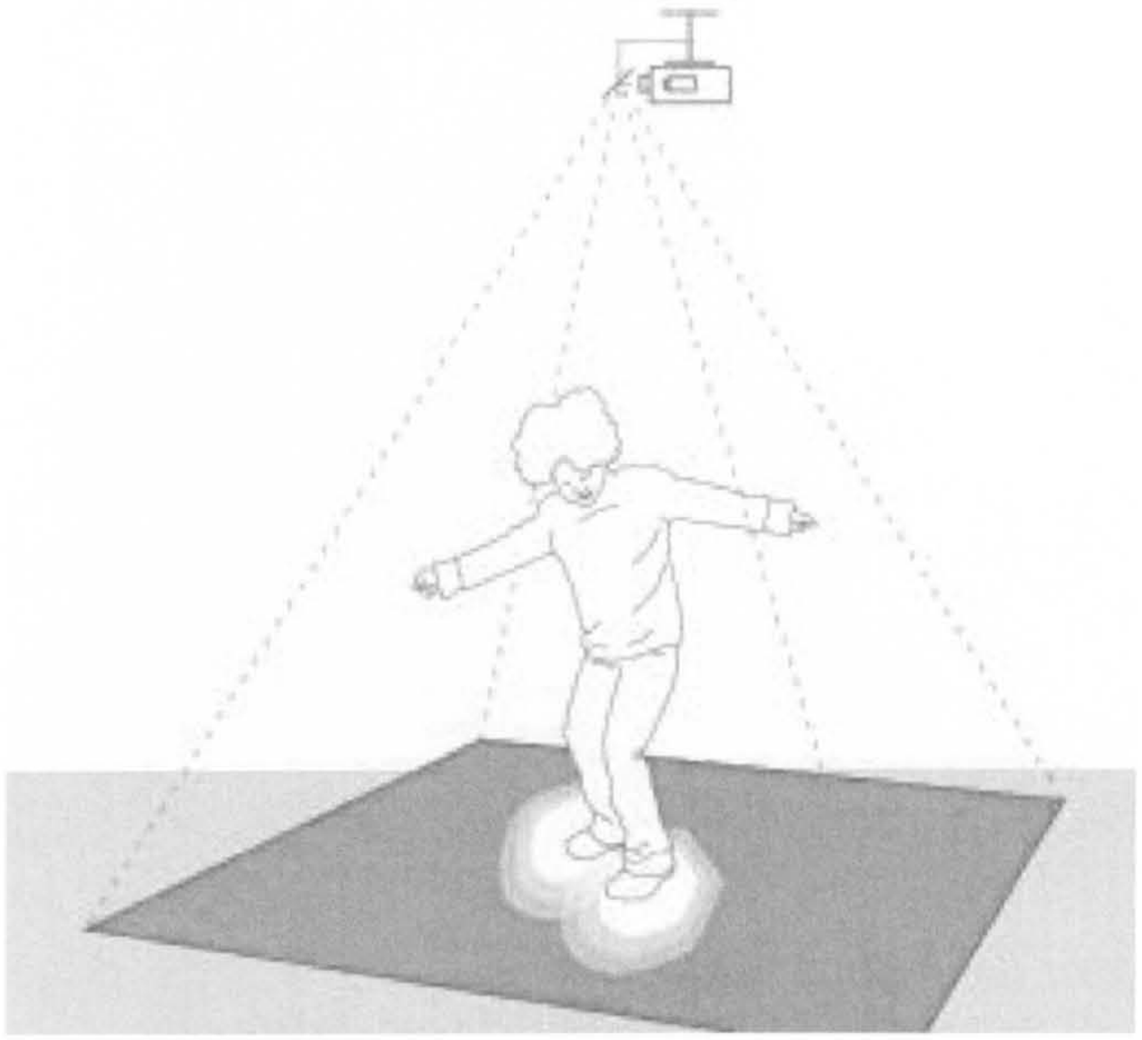


Figure 54: Similar solution to Dance Floor Moves technology at http://www.feedtank.com/

The text in the rationale concerning this solution (on page 277) does not specify either the components or the physical refurbishments needed to support the solution accurately. However, some precedents for this solution, using the same technology, were introduced in the rationale thus permitting comparison.

Figure 55: Precedents to the game solution: Dance Floor Moves from http://www.feedtank.com/

The justification for the proposed solution was that the games would deal with the perceived problems of the site, harnessing them to the full potential of the solution itself. Pedestrians could be engaged by the games leading to an enhanced level of socialization, thus increasing their permanence in the place. The boundary between the sides could act as a marker for the two halves of the playing field, and the low level of luminosity would satisfy the lighting environment

requirements for the correct functioning of the projectors. Also the settling up of a game system was supposed to encourage people to use the space at all times of the day.

Figure 56: The façade of the Alfred Denney building and its pedestrian area.

The second solution concerned the side near the Alfred Denney building. Its façade was considered imposing and lifeless, whilst a lack of activity or interactivity means that this part of the concourse takes on a lifeless quality. To reinforce the affected qualities of Territoriality, Identity (the original text mentions Individuality) and Ambience, it was proposed that a digital installation that would both inform people on the site, whilst also being responsive and interactive. The installation would also be visually striking and abstract in the way that it visualises information; in this way it would be made to look as much like a piece of art as a giver of information. It was considered important that the installation could be adapted so that the displays could be changed in order to keep the piece interesting to the users of the site at all times.

Again, the group used the observation of similar solutions (precedents) to explain their design. Mentioning the work '*Bitwalls*' from Christian Moeller in his effort to create interactive facades in Bielfield, Germany, the group adopted what Moeller called "the mechanical pixel". This consists of a mechanical element which can display a white or black card in accordance with the interpretation of digitized images. As such, the mechanical pixel can change the displayed image quickly, and is durable in outdoor conditions.

Figure 57: Christian Moeller's '*Bitwalls*' designed for Elbe and Bielfield in Germany in 2002. Part of the river landscape near the parking is displayed in the surface of a totem with mechanical pixels.

The installation would focus on the representation of the user's movement, an image of which would be captured by cameras on the ground floor of the Alfred Denney Building. Sensors would register how many users were inside or in transit through the entrances. The occupancy of the building, determined from the number of people detected going through the sensors during the time, would be graphically expressed on the vertical axis, expressing the number of people, and axis x, the time. At the same time, cameras in front of each panel would capture and translate the silhouette of the passers by, representing them over the graphic, shadowing their movement. The group alleged that the screen could either work as a giver of information, in terms of the way it can track users of the site and display the information visually, or it could work as an interactive display, giving life to that side of the concourse space.

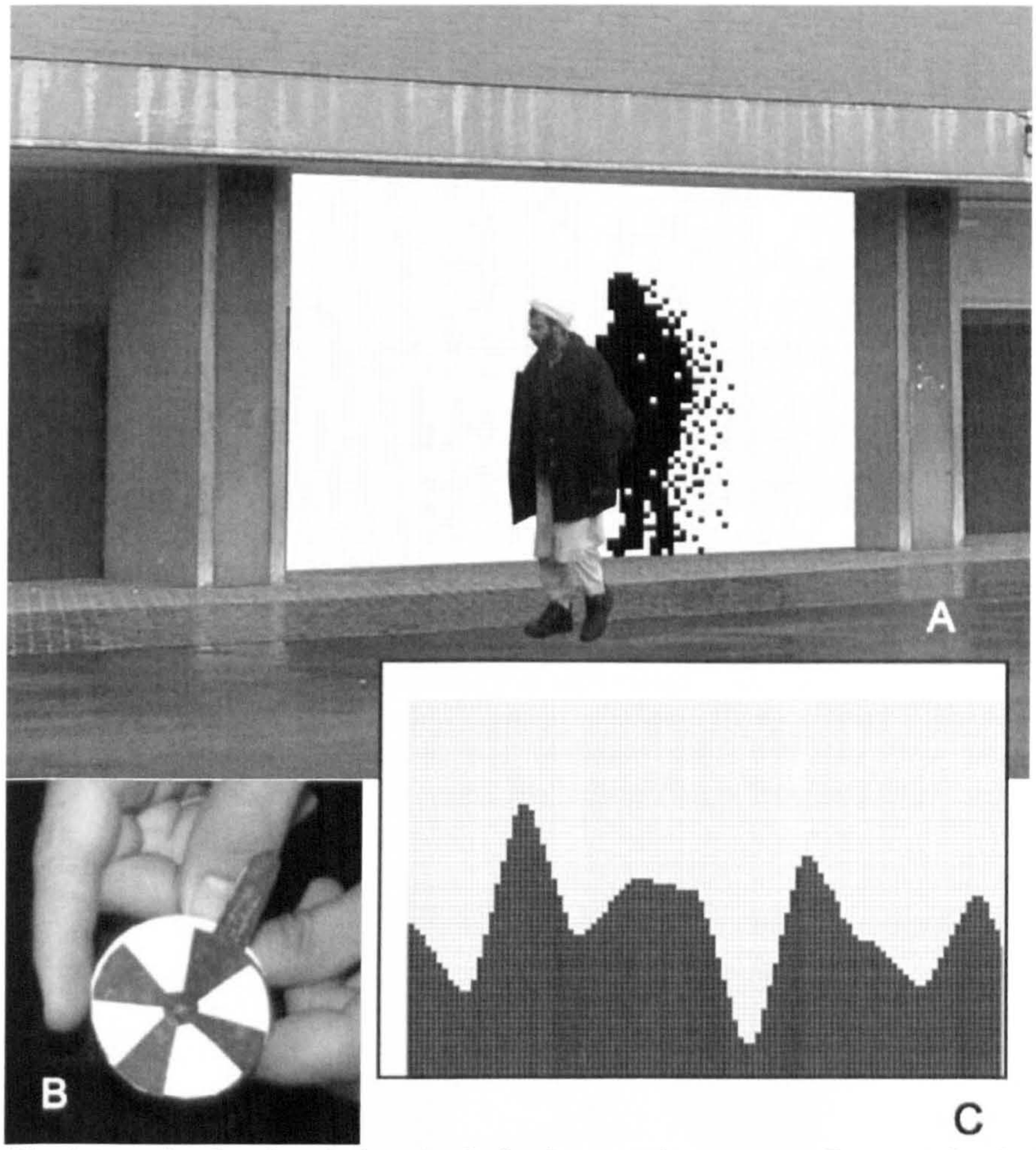


Figure 58: The interactive facade solution. A: shadowing users' movement; B: an mechanical pixel; C: the graphic expression of the occupancy.

The third solution is concerned with the fly-posting in front of the Union of Students building, which is considered a problem since people that distribute flyers in that place act invasively, reducing the scope to perform other activities, creating waste and, at the same time, crowding out information which is less intrusive and not as abundant as the flyers.

The proposal was to install a system which would replaces the flyers, allowing individuals to decide what information they receive, while supporting alternative uses for the space. The system would incorporate the already very well established and simple interactive aspect of Bluetooth messaging. Transmitters would be placed along the concourse replacing the flyers with a less

invasive and more direct form of advertising. By using mobile phone technology a large majority of people would be able to access information without the expense of having to buy new hardware devices. The system would allow the user to control the information received by separating the advertisements into relevant groups, allowing users the option to download specific messages relating to their interests, benefiting both them and the advertiser. Bluetooth can also be transmitted selectively as it can cover small designated areas, from 1 to 100 metres, and, in order to receive information, it has to be accepted by the user.

Figure 59: Displays with Bluetooth transmitters.

Once more, the group presented the antecedents of the idea of using Bluetooth technology, by mentioning that the use of Bluetooth technology in advertising is already widely accepted as a low cost and efficient alternative to WI-FI in low demand solutions. By specifying a Bluetooth network over that of a WI-FI the costs will be kept to a minimum and it will also allow most owners of mobile phone handsets the opportunity to access the information without any extra cost.

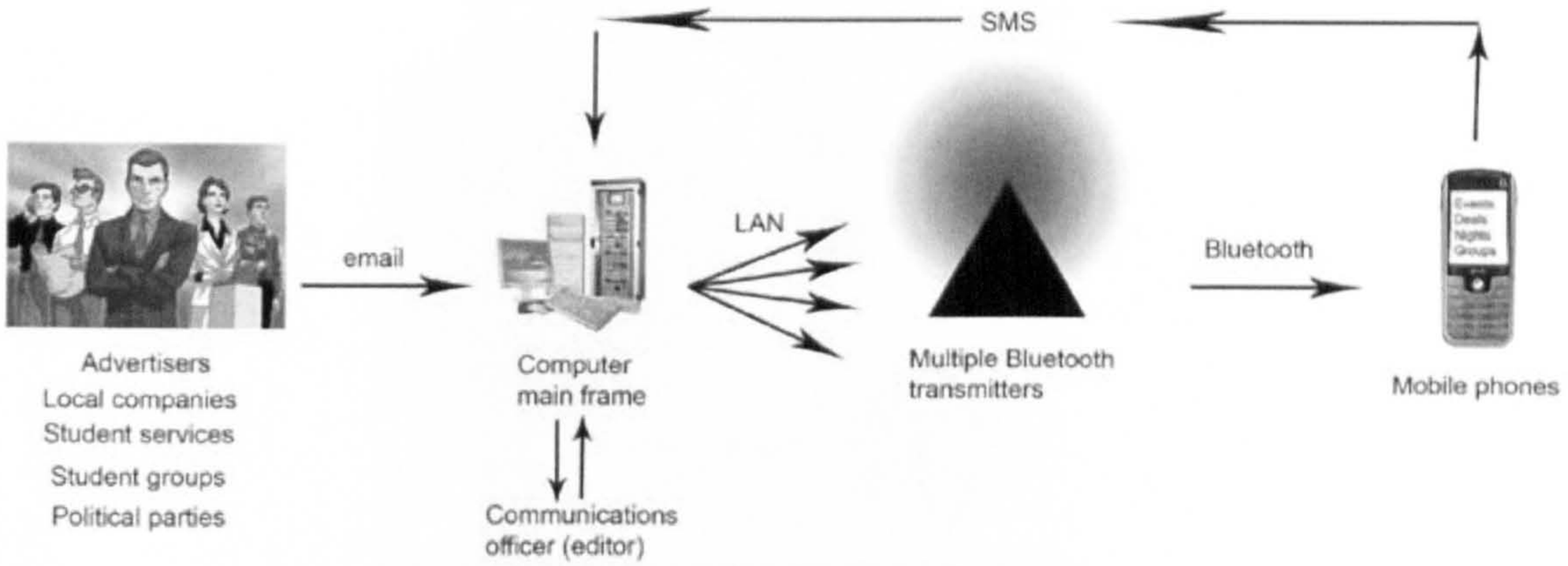


Figure 60: Scheme of the Bluetooth System to the area.

Figure 61: Some adverts are already made through Bluetooth technology, as it is shown in this situation in the place in front of Union of Students building.

The system would primarily replace the people who give out flyers in the concourse area, although the transmitters will also incorporate a ring of seating around them. Each transmitter will relay different topics of information. Times and dates of live music events in Sheffield could be sent out by one while another could be sending out sports results and information about students' events. The topics of transmission will be displayed on the transmitter posts which would also illuminate the routes by night.

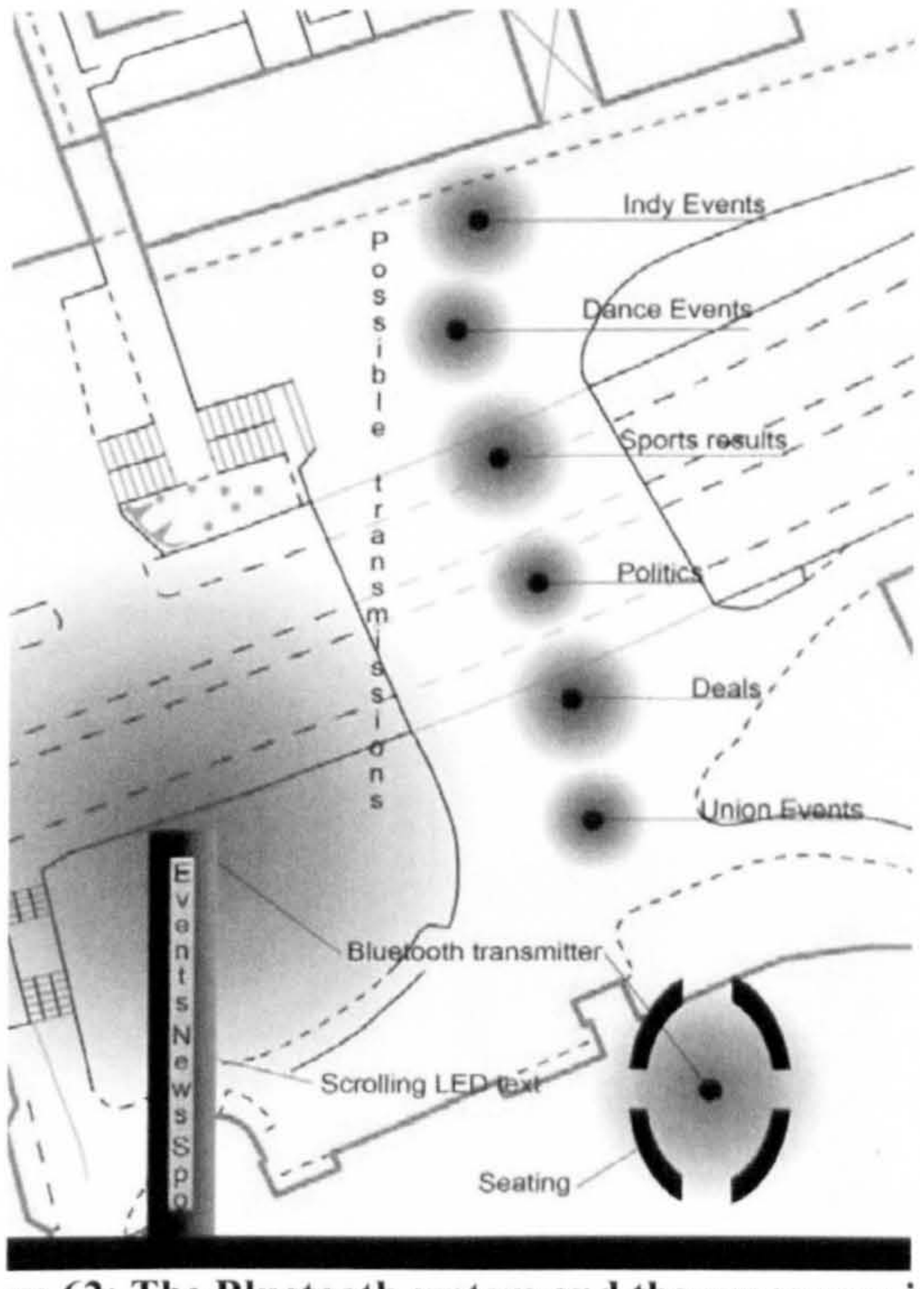


Figure 62: The Bluetooth system and the space required.

By dividing up the advertisements in terms of different topics, the system would allow individuals to specify what information they would like to receive by just entering the area of transmission

defined by the seating arrangement. The group suugested that the proposal was designed to encourage other more social activities which would come about as a result of gathering together people of similar interests in the same area, thus facilitating socialization and conversations between people who would otherwise have never been in close enough proximity to meet. Figure 62 shows the seating proposed around the post arranged in a sociopetal positions to encourage the face to face meetings.

According to the project, the system of transmissions would be regulated by an individual elected by the members of the student union (the communications officer), and it would be their job to gather the relevant information, programme it into the system which relays it to the transmitters. The scheme was supposed to be financially beneficial to the university and the advertisers, saving money on printing the flyers while encouraging more selective advertising.

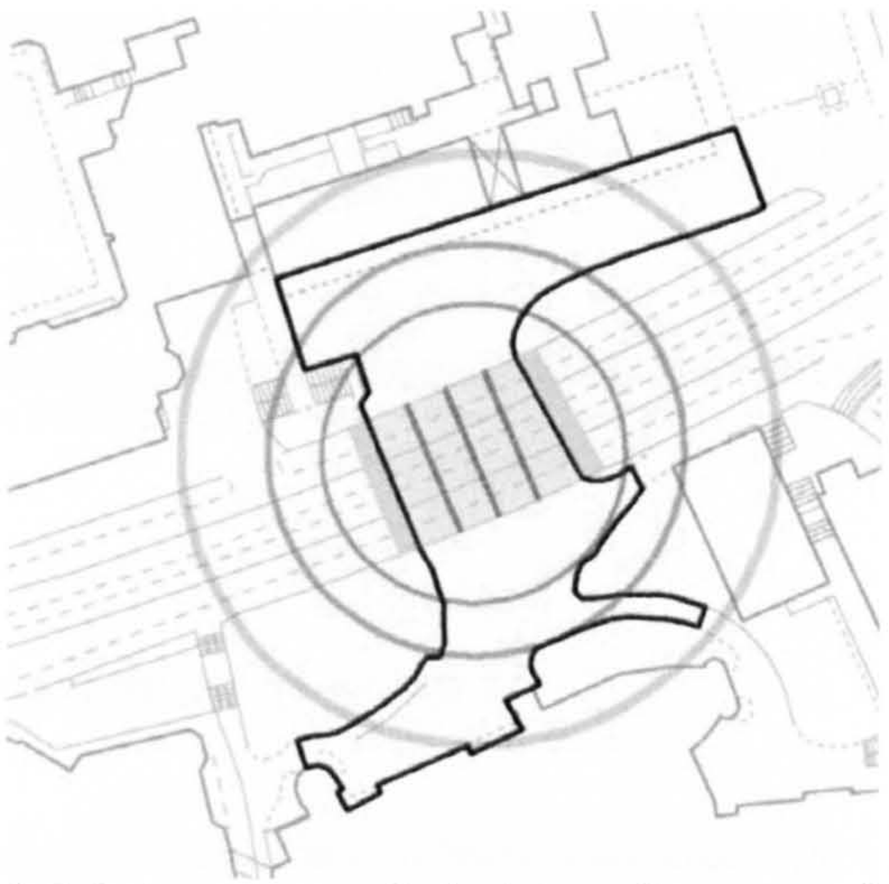


Figure 63: Fourth Solution of group I: the interactive screens in the underpass.

The fourth solution was located again in the area underneath the flyover. Three electronic screens that span the width of the underpass would act as interactive information points at the centre of the concourse, generating cohesive ambient mixing both virtually and physically. The outer screens would communicate '*by-chance*' information whereas the central screen would permit more possibilities for interaction with pedestrians.

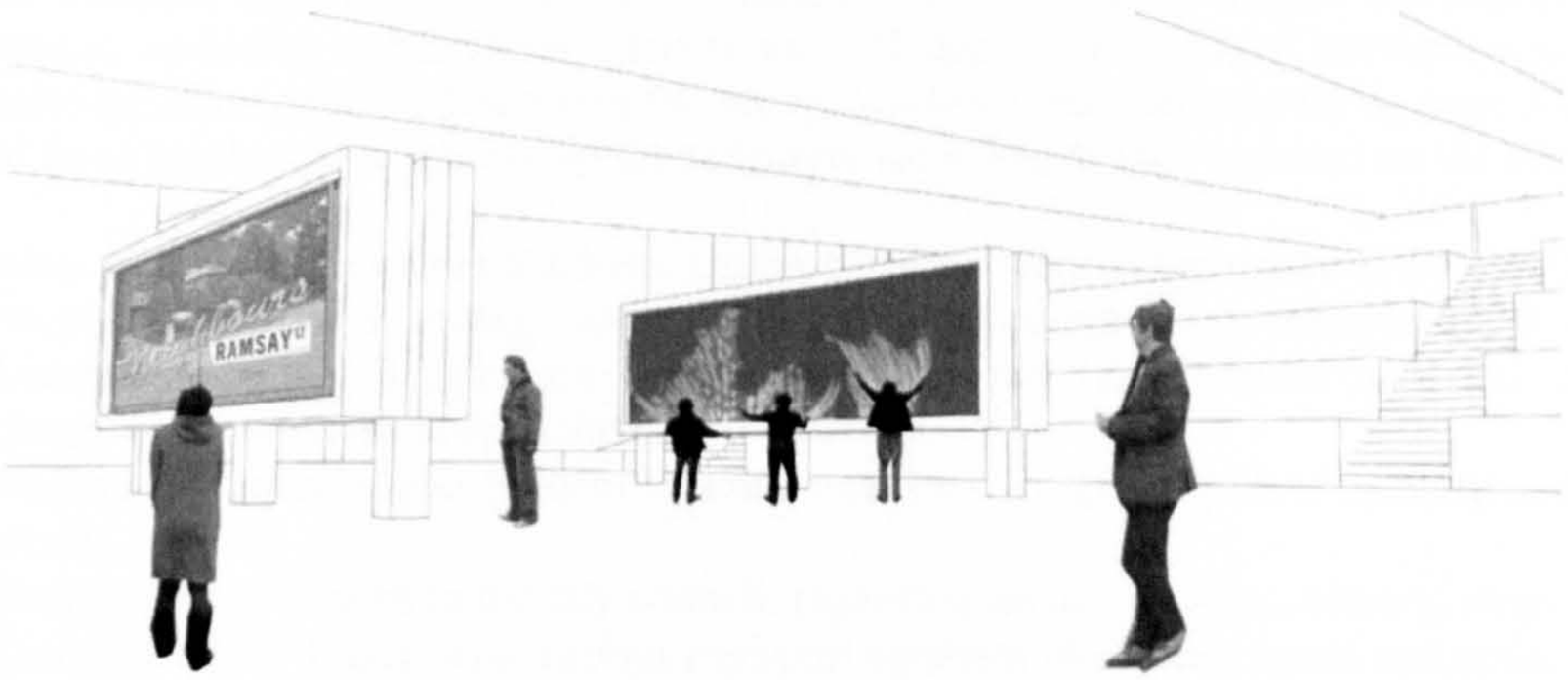


Figure 64: "Electrical Screens" and seats in the underpass.

The group's intention was to provide different '*contents*', creating a central area where the pedestrian movement would be slower. Seats on both sides of the underpass would permit users to

stop and exchange information via Bluetooth with laptops. The screens would display message boards via Bluetooth and internet connections, enabling the use of '*blogs*', and the facilitation of public debate and event advertising. The description of this solution tries to give an idea of a mixture of physical and virtual resources, gathering students from all places on the campus by external links with the displays.

The specification of the technology for this solution was briefly commented on when the rationales pointed out that the electronic screens would facilitate multiple forms of interaction, using devices such as touch screens, Bluetooth and external links, enabling the display of television programmes, films, permitting chats, '*blogs*' and other exchanges through the internet (see page 294). Figure 65 shows a section of the underpass, elucidating the position and size of the screens. The actual structural columns of the bridge were not represented.

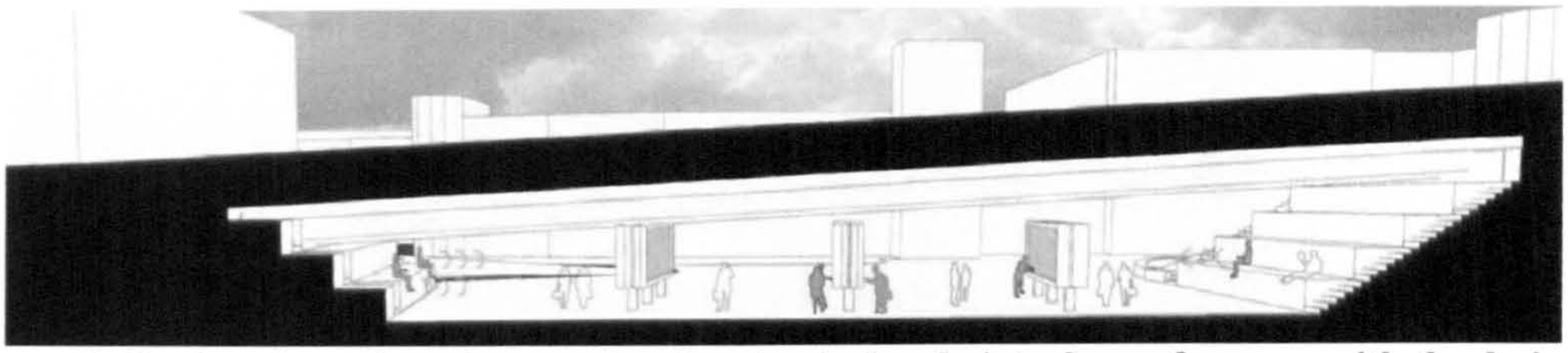


Figure 65: Section through underpass showing physical and virtual use of screens with the design of the seating area.

7.3.2. Solutions proposed by group II

Group II stated that the analysis of conflicts had been conducted with a view to the formulation of an array of strengths and weaknesses which were highlighted in the description of the conflicts. The group, thus, decided that creating a conceptual platform in order to aggregate thematic solutions, to generate a unique concept to the project, as a means of granting its coherence as a totality, thereby avoiding the mere juxtaposition of solutions. Five key attributes were generated and the theme was developed as a project concept. Thus, group II stated that their project results arose from a intention to create '*a seamless and interactive information corridor preserving and protecting a vibrant dynamic university atmosphere*' (see page 310). According to the rationales, from each attribute contained in the former sentence, design concepts were developed through various means, including architectural interventions, IT applications, social interventions, outdoor at and landscape interventions. Thereafter the group developed the table shown on page 312, which originated from another table specifying the solutions according to each location on the site.

Interventions in the area near the Students Union building were called place definers. The place definers would be installed at strategic locations to share and communicate information about:

- Location - helping locate new students who are not very familiar with the university campus and functions around the Union building;
- Various commercial and Student Union's activities - regarding shop opening and closing times;
- Sheffield City - linked to the city council, regarding transport routes, history, maps;
- Transportation - linked with various transport agencies like trains, buses and taxis;
- Downloadable digital data - such as maps, directions, via USB or Bluetooth devices;
- Advertisements - incorporated to generate resources for the maintenance and installation of the devices;
- Scheduling Services - permitting users of the concourse to advertise future events etc.

The area near the Alfred Denny building received what group II called "*Networked Display screens*", which were described as screens managed by the University Information Systems providing various items ofimportant information, such as:

- Availability of workstations in various places in the buildings of campus;
- Adverts in order to maintain the system;
- Displays of student work, art and sketches;

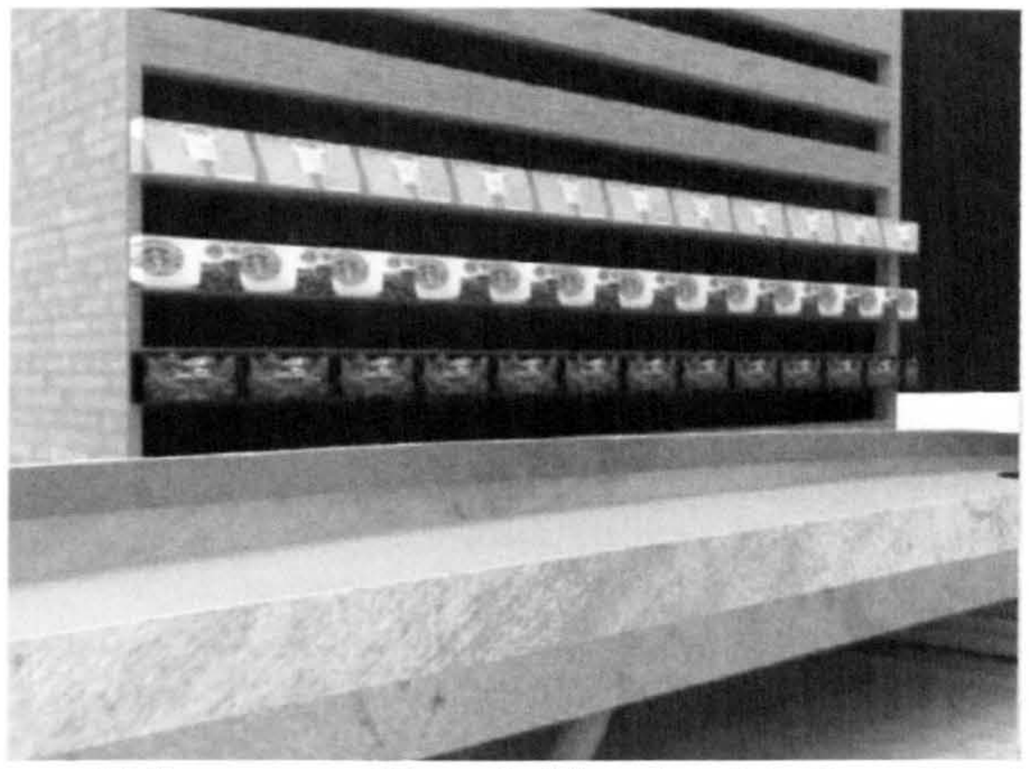


Figure 66: A model from group II, probably related to the networked displays.

Finally, the group gave a list of non IT design solutions which comprised:

- Near the Student Union building, a new demarcation of seatings, in order to reduce the speed of pedestrian traffic during summer non-examination periods;
- On either side of the concourse bridge, changes in the pavement creating areas demarked for speeches, pamphlet distribution and the like;
- In both of the buildings at either end of the concourse, the structural supports for the projection screens.

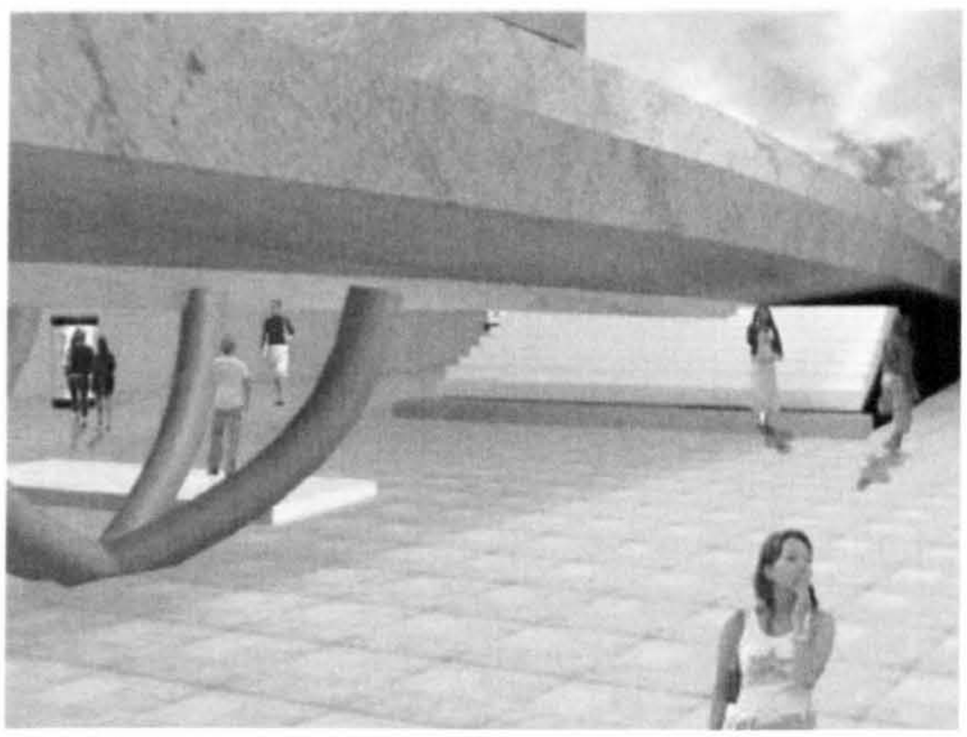


Figure 67: Physical intervention suggested by group II underneath the flyover.

7.4. Evaluation of the projects

Whilst still following the same structure as the previous cases, this section will examine the two projects looking for evidences that demonstrate whether or not they satisfied the expected outcomes derived from the key questions. The same order is adopted to describe the outcomes achieved, as has been shown in section 4.5.3.

7.4.1. Evaluation of project of Group I

Thus, the Campus project, by means of the drawings and rationales from group I, was examined considering the items of evidence that demonstrated that the framework had given the architects the means to:

1. Explain the qualities of place (territoriality, Privacy, Identity and Ambience);

This outcome was achieved, as can be seen on page 269, in the Appendices, where the group stated that the project started with the identification of conflicts affecting the place's qualities. A small account was given by paraphrasing those concepts in a new text.

2. Explain the topology of the elements of place (centrality, enclosure, internal area, internal directions, entrances);

This outcome was achieved. Yet on page 269, the architects demonstrated their understanding of the topology of place and the digital technologies components in the following way: '*...centrality, horizontal and vertical directions, enclosure, internal area and entrances are components of place and those components are defined by events that happen in the space. ICT solutions can integrate with a place and become as much a component of place as any of these physical constraints.*'

3. Given a place, identify the conflicts between spatial elements and activities in places eliciting how they interfere with the qualities of place;

This was satisfactorily achieved. The rationale included tables with the identification of conflicts, and a description of each conflict, relating them to the place qualities. From page 271 on, the conflicts were extensively analysed and, once again in the description of the solution, they were connected to each instance of interference with the place's qualities.

4. Compare types of digital technologies components (to sense, to act, and to represent the place);

It looks as if this outcome was not achieved, despite the fact that the group had been dealing quite reasonably with the specification of types of digital technologies components. But actually this outcome concerns the observation of whether the whole rationale expressed a coherent manner of thinking about IT in relation to place, classifying modes to sense, act and represent the place. In this sense, it was not achieved.

5. Explain the topology of digital technologies components and its potential interferences with the place's qualities (explain the correlations between interiority/exteriority, visibility and appropriation and the functions of the digital technologies components);

There is no straightforward reference for this correlation, as might be expected to come about via a description given in the rationale. However, some solutions demonstrate that the topology of the digital technologies components and the topology of the place were to be considered together. This can be observed in the care with which the group depicted all the solutions in small schemes,

showing topology and the affect of the digital technologies components. For instance, the Projected Game Solutions were depicted as using the enclosure obtained underneath the flyover, using the definitions of that place to project, dividing its internal areas, and generating centrality by interest in the projections. Also the other solutions considered the internal directions of the place in order to propose alternatives to the application of the components in the solution named "interactive façades" and creating areas to the transmitters along the internal directions determined by the main paths.

Figure 68: Topology of place and topology of IT in the solutions: first picture is the enclosure to the Interactive games, and the second represents the transmitters (dots) along the paths (pink and yellow lines), in the Bluetooth Advertisement Solution.

However, there were no explanations of those correlations, as a strategy to test and justify the solutions \acting to invigorate the qualities of place. For these reasons, this outcome was considered partially achieved.

6. Create solutions to the identified conflicts by using digital technologies components and spatial elements;

Analysing the conflicts enumerated in the report and the solution provided by Campus Project Group I, it is possible to see how many conflicts were solved by IT usage. However, the conflicts were not enunciated as oppositions, revealing action X (versus) spatial element. Rather, those oppositions could only be deduced indirectly. Accordingly the list is as follows:

- The first conflict was enunciated as '*flyover*'. This was interpreted as referring to a conflict between the action of people in socializing in appropriated space and the lack of informal seating underneath the flyover. It was also considered the source of another conflict caused by the natural shape of the bridge, which divides the place and breaks the continuity of activities between both sides of the space. Since it is stated in this way, it is possible to consider that the 'games solution' was dealing with this division, by integrating the activities through IT use inside the enclosure of the flyover, gathering the players and even the passers by. The seats were provided by means of another solution termed "electrical screens" (see Figure 63).

- '*Flyering*' was the second identified problem which referred to conflicts between the action of distributing flyers and bills underneath the flyover and the actual area in the place, since this area does not in fact provide any support for that activity, and, thus, it interferes with the spontaneous actions of others and creates waste. The Bluetooth advertising solution created by group I can be considered a full response to that conflict, mixing the operationally of the IT gadget with the attempt to propitiate a socializing atmosphere.

- '*Flypostering*' is the conflict caused by the posters and the visual confusion generated by the absence of the management of these. Also, this conflict was addressed using the solutions generated in the strategy previously described.

- '*Social facilities*' is described by group I as the conflict between the activity of informal socialization and the lack of amenities providing basic elements for a meeting. Some of the solutions to this conflict were physical interventions, such as the creation of seating area underneath the flyover. However, solutions such as the Projected Games and the Interactive Screens were intended to propitiate conditions to support the informal meeting and spontaneous social gathering.

- The conflict related to the presence of bikes in the middle of the flyover space was solved by their physical removal, since they were not related to the use of IT.

- The conflict related to the emptiness and lack of Identity near Alfred Denny building was solved by means of an interactive façade using mechanical pixels to invigorate interest in the area.

Thus, as can be observed, in six solutions, only one was solved without the use of IT gadgets. Despite this, on the basis of the criteria adopted, this meant only a partial success was achieved, and it is important to note that the solutions were far more efficient in comparison with the previous cases.

7. Implement the IT solutions as an integrated part of the place's topology;

All the solutions were integrated with some particularity of the area's topology where they were inserted. In the Projected Game Solution, the centrality of its internal area created by the game was considered a factor that could contribute to the integration of the sides of the concourse bridge (see Figure 53on page 154). In the Interactive Façade Solution, the extension of the enclosure of that place, given by the façade in its directionality, was invigorated with interactive visual patterns and a '*logical reader*' of the number of people inside the building (see Figure 58 on page 157), whereas in the Bluetooth advertisement Solution, the topology was also considered, spreading central points created by transmitters along the internal direction of the place (see Figure 62 on page 159); in the last solution named '*Electronic screens*' the surfaces of the displays are positioned according to the flux of pedestrian traffic in line with the internal direction of that place (see Figure 63 on page 160).

8. Justify the use of each IT component in terms of their contributions to the solution of conflicts, eliciting their influence over topological characteristics such as interiority/exteriority, visibility and appropriation;

This outcome refers to the skill in justifying the components of IT in terms of their connection with the places topology. This is supposed to be achieved by means of the use of the tables described in Section 3.6 on page 69. Since the reasoning about the operational connection of those tables was created after the delivery of the course module in 2007, the architects were not provided with them.

9. Plan the IT system together with physical interventions that will help to solve the detected conflicts;

As has already been pointed out, all the solutions provided were integrated with physical interventions, simultaneously solving the problems created by conflicts and the need to support digital technologies components. Evidence of this can be clearly observed in the solution named 'Bluetooth Advertisement' in which spatial configuration used the transmitters as a central point around which sociopetal seating was provided. Spatial and technical solutions reinforce each other in this example, and the gaps occasioned by a lack of activities and suitable public amenities were solved.

10. Plan physical changes to support the planned IT system;

So as to be supported correctly by the physical interventions provided, this outcome intended to observe how accurately the system was specified in the first place. Despite the fact that the IT component was not specified, physical supports for them were specified in schematic drawings and computer generated models. However, this outcome is to be considered as having been only partially achieved since, given the actual space available in the concourse bridge area, some of the solutions were not accurately designed. An example of this is the Electronic Displays solution, the drawing for which did not represent the original structure of the overpass, creating an ambiguous graphical expression.

11. Specifying the spatial requirements for the IT system adopted;

This outcome, for similar reasons to those just outlined, is also considered only partially achieved. Whereas the prior outcome referred to the system as a whole, this objective regards the specification of the spatial elements that support IT. An example of the non-achievement of this can be seen in the solution named 'Interactive Façade', which, despite describing the digital technologies components and its connection with the mechanical pixel, did not clearly demonstrate how the panels would be attached to the façade. Another negative example is the solution 'Projected Games' which did not specify the spatial requirements to the person in charge of maintaining the system.

12. Plans and schemes of IT systems such as gadgets in the place;

This outcome can be observed indirectly in some of the drawings of group I. It aims to detect whether the architects got a general idea of the dynamic functioning of the technology, considering both the users and the place. An example of this was in the solution named '*Bluetooth Advertisement*' in a small drawing expressing the relationship between the system and the movable devices in place (See Figure 60: Scheme of the Bluetooth System to the area.) Other example was a scheme that is described as in '*Electronic Displays*', in which the connection with laptops and mobiles is mentioned in passing, or in the use of moving detectors as in the solutions '*Projected Games*' and '*Interactive Façades*'.

13. Specify the digital technologies components and gadget functions in the system so as to permit exchanges with other fields as computing sciences;

The evidence that can be taken as the expression of this outcome was the attempt to exemplify each solution with precedents, showing how the components specified in the solution had been used in other circumstances. This approach permitted the creation of inferences about the technology used and enabled discussion with related fields and manufacturers. At the same time, in order to make sure that the technology was adequate to the requirements of the project, it gave some idea of the innovations that had been needed in the solutions cited as precedents.

14. Justify the solutions adopted, clarifying the accomplished advantages.

This outcome is considered to have been partially achieved because the justifications were somewhat linearly aligned with the detection of conflicts. This means that all the reasons cited in the solutions were related to the detected conflict, but only in one case was the solution compared with others in terms of advantages. This was the case for the Interactive Façade on the ground floor of the Alfred Denney building, where the group, reasoning about a solution, mentioned firstly a Café or shop to solve the conflict, but afterwards changed it, creating instead the solution based on displays with mechanical pixels.

15. Criticize the solutions designed to provide the theory with feedback.

This objective was not achieved: there is no evidence of any criticism of the theory in the drawings and in the rationale. However, the observation of the architects permitted the inference that such criticism was developed, and this is commented upon in Chapter 8.

Finally, summarizing the results of the outcomes obtained through the analysis of the project, it is possible to get the following table:

Expected outcome according to the key questions	**Observed outcome**	**Description of the evidence observed in the drawings and in the rationale**
1. Explaining qualities of place.	Achieved.	There is a description with those definitions in the rationale.
2. Explaining topology of elements of place.	Achieved.	The rationale mentioned the elements of the topology associating them to the place.
3. Identifying of conflicts.	Achieved.	There are tables identifying the conflicts.
4. Comparing types of IT components.	Not achieved.	There is no evidence of such comparison, neither the definitions of elements to sense, act and represent the place
5. Explaining topology of IT components.	Partially achieved.	Solutions demonstrates that the topology of the IT components and the topology of the place were been considered together.
6. Creating solutions with IT.	Partially Achieved.	Five in six solutions were using IT to solve the identified conflict.
7. Creating solutions Integrated in the place.	Achieved.	Solutions follow place's topology accordingly.
8. Justifying the use of IT.	Not Achieved.	Justifications were not described as being connected with the place topology.
9. Planning a system of IT	Achieved.	Drawings show the system integrated
10. Planning physical supports to IT components.	Partially achieved.	Some solution were not accurate, and others were quite confuse.
11. Specifying spatial requirements to IT.	Partially achieved.	Some solutions were only schematically expressed.
12. Elaborating schemes of IT systems.	Achieved.	Drawings and descriptions concerned to this outcome.
13. Specifying technically IT components.	Achieved.	Precedents solutions exemplify the technology adopted.
14. Justifying the solutions in terms of advantages.	Partially achieved.	Only one solution were tested in confrontation with other possibilities.
15. Feedbacking to theory.	Not achieved.	There is no evidence of this outcome.

Table 27: Outcomes achieved in the Gwangbok Street Project.

7.4.2. Evaluation of project of Group II

Group II, in turn, produced another project for the Campus Concourse Bridge area the examination of which will permit scrutiny of evidence that shows whether the framework has given the architects means to:

1. Explain the qualities of place (Territoriality, Privacy, Identity and Ambience);

This outcome was achieved. The rationale contains, from the very beginning, references to those qualities, as can be seen on page 295.

2. Explain the topology of the elements of place (Centrality, enclosure, internal area, internal directions, entrances);

There is no evidence of any explanation related to those concepts. The architects mentioned only that ICT interventions would be one method amongst others (architectural interventions, social interventions, and art and landscape interventions) to solve the identified conflicts.

3. Given a place, identify the conflicts between spatial elements and activities in places eliciting how they interfere with the qualities of place;

Evidences of the achievement of this outcome are plentiful as can be seen in the sequences of tables drawn up to analyse the conflicts.

4. Compare types of digital technologies components (to sense, to act, and to represent the place);

There are no comparisons of these components.

5. Explain the topology of digital technologies components and its potential interference with the place's qualities (explain the correlations between interiority/exteriority, visibility and appropriation and the functions of the digital technologies components);

The framework was implemented by means of a conceptual platform to formulate a guide to the creation of the project. However, that platform did not correlate the qualities with the topology of the components, despite those concepts having been available in the framework by that time.

6. Create solutions to the identified conflicts by using digital technologies components and spatial elements;

The number of conflicts simultaneously solved by IT and physical interventions was obtained by analysing the conflicts enumerated in the report and the solution provided by Campus Project Group II, in the rationale and drawings. The conflicts identified were named thus:

- *'Movement Patterns'* refers to the conflict between the need for clear orientation through the territories inside the place and the lack of markers and routes along the paths. The solution to this conflict, among others, was provided by means of place definers, which were supposed to give the passers by information about the surrounding buildings and their functions. However, the group did not define the technology with precision, and there is only vague references to the use of Bluetooth technology;

- *'Uninviting Soft Landscaping areas'* is a conflict which refers to the clash between the need for socialization in public and the lack of seating. The solution was strictly physical, and there is no evidence of with the provision of other solutions using IT.

- '*Weak sense of place under the overpass*' is a conflict between the need for the integrity of the concourse area and the territorial division created by the bridge. Underneath the overpass, the architects observed a lack of amenities. To enable this connection of the both sides as a place, they created the concept of "seamless" to the place. The solution was achieved by utilizing the visual similarities on both sides of the bridge by means of the networked displays screens.

- *'Inadequate signage'* refers to the conflict caused by the need for orientation and the lack of the signals. This conflict is actually the same as that described under the name *'Movement Patterns'*, the only difference being that the first was also interfering with the territoriality of the place. The solutions to that conflict, as it has been noticed, were given by deploying IT in ground signals, demarcations in the internal areas and so on.

- *'Underutilization of space'* describes the conflict between the need for a place that has a balanced population and the lack of security associated with times when there is no movement through the place at all i.e. when the place is deserted. The solution to this was seen to be a matter of providing information and promoting activities that would invigorate the population of the place during these hours. Thus, the solution implied IT.

- '*Lighting Levels*' pointed to the conflict between the need for visibility and the lack of lighting in the whole area. The introduction of displays and projections on areas of the walls and ground was considered to be an IT-supported solution.

- *'Isolated Zones'* replicates the reasoning outlined for the conflict named *'Underutilization of space'*, an IT solution for which was provided by means of attractions that would take the form of displays to be called '*place definers*'.

- *'Nocturnal safety of passers'* is a problem associated with the conflicts previously described named *'Underutilization of space'* and '*Lighting Levels*'. All of them received the attention of IT solutions that were associated with physical interventions.

- "Flyer distribution" is a conflict related to the lack of a cohesive system for the promotion of events and the dissemination of information, and it was solved by the use of the same IT that was deployed in the '*Place definers*' solution.

- '*Blank façade of the Stoddard building*', as the name indicates, deals with the feeling of monotony caused by the repetition of elements and the lack of proportions of them. The architects were actually referring here to the Alfred Denny Building, as it can be seen in their rationale (see on page 295). The networked displays were considered an IT-based solution to this conflict.

Thus, the outcome was only partially achieved, since not all the conflicts were solved by using IT.

7. Implement the IT solutions as an integrated part of the place's topology;

This outcome was partially achieved. The architects barely described the conflicts detected, has and this weakened the internal logic of the method. Also, there is no relevant graphical material to explain the solutions, and neither were their descriptions precise. The topology was vaguely mentioned in the proximity with the buildings.

8. Justify the use of each IT component in terms of the contributions made to the solutions of conflicts, eliciting their influences over topological characteristics such as interiority/exteriority, visibility and appropriation;

This outcome was not achieved, since there is no evidence showing that the architects were conscious of the relationship between IT and the properties that were related to the qualities. Again, the framework was ignored as far as those concepts are concerned.

9. Plan the IT system in conjunction with physical interventions that would help to solve the detected conflicts;

This objective is regarded as having been partially achieved, since the physical interventions were not designed with appropriateness in mind and the system of information was only described inasmuch as it specified types of contents and probable functions.

10. Plan physical changes to support the planned IT system;

Again, the lack of graphical elements to clarify all the solutions means that this outcome can only be regarded as having been partially achieved.

11. Specifying the spatial requirements of the adopted IT system;

This outcome was partially achieved. The gadgets were not specified in terms of clear spatialization, including all the elements necessary to understand the proposal. For instance, the position and number of the Networked Displays and how they were to be given protection were not mentioned in the project.

12. Plan schemes of IT systems to be used as gadgets;

This was not achieved. The architects mention mobiles and other gadgets, but did not introduce schemes explaining them.

13. Specify the digital technologies components and gadget functions in the system so as to permit exchanges with other fields such as computing sciences;

This was partially achieved. Since the specifications were barely made, functions were described with inaccuracies, being the only way to discuss the subjects through other fields of knowledge.

14. Justify the solutions adopted, clarifying the advantages accomplished.

There is no comparison made with alternative solutions. The architects were limited to the expression of only a list of functions without clarifying the advantages over other solutions.

15. Criticize the solutions designed in order to provide the theory with feedback.

There is no evidence of this. However, the adoption of a conceptual platform superimposing the framework can be regarded as a means of modifying and adapting the theory, which could regarded as critical reflection.

Therefore, summarizing the results of the outcomes obtained through the analysis of the project, it is possible to get the following table:

Expected outcome according to the key questions	**Observed outcome**	**Description of the evidence observed in the drawings and in the rationale**
1. Explaining qualities of place.	Achieved.	There is an initial explanation in the rationale.
2. Explaining topology of elements of place.	Not achieved.	There are no evidences related to the use of those concepts.
3. Identifying of conflicts.	Achieved.	There are tables identifying conflicts.
4. Comparing types of IT components.	Not achieved.	There are not comparisons about those concepts
5. Explaining topology of IT components.	Not achieved.	The adopted conceptual platform did not contemplate those concepts.
6. Creating solutions with IT.	Partially achieved.	Some solutions were described strictly as being physical.
7. Creating solutions Integrated in the place.	Partially achieved.	Topology was vaguely mentioned in terms of proximities.
8. Justifying the use of IT.	Not achieved.	There is no evidence about the justifications in terms of place characteristics.
9. Planning a system of IT	Partially achieved.	Only descriptions for some solutions were barely described.
10. Planning physical supports to IT components.	Partially achieved.	Only few drawings specify some solutions. Others are missing.
11. Specifying spatial requirements to IT.	Partially achieved.	There are partial descriptions which did not specify concisely the requirements.
12. Elaborating schemes of IT systems.	Not achieved.	There are not schemes explaining the system.
13. Specifying technically IT components.	Partially achieved.	Only the specification of possible functions to the components of IT applied drives the discussion about the technology.
14. Justifying the solutions in terms of advantages.	Not achieved.	There are no comparisons among alternative solutions.
15. Feedbacking to theory.	Not achieved.	There is not evidence of criticism.

Table 28: Outcomes achieved in the Gwangbok Street Project.

7.5. *Framework amendments*

Following the same structure employed in the previous chapters, this final subsection aims to look at the modifications to the framework that resulted from the analysis of the two projects that constitute the third case, the case of the Campus Project, 2007.

By the end of the module '*Interactive Urban Visualisation Modelling*', it was possible to analyse the projects of the two groups of architects that used the framework to support their design. Observing their drawings and rationales made at that time, it was clear that the correlations between digital technologies components and the topology of the place should be reinforced in the framework.

This first conclusion arrived at was that the specification of digital technologies components in the projects was always problematic for the architects, as can be seen in the previous cases. The architects vaguely justified the use of digital technologies components in a manner that correlated them with the qualities of place, relating the functions of those components to physical aspects that were essential to the place's qualities. After analysing systematically the results of the projects according to the expected outcomes, it was possible to validate that first observation. As can be seen in Table 27 and Table 28 (see on page 167 and on page 170), three outcomes were not achieved in any of the two projects concerned with Sheffield University Campus:

- Outcome 4: the architects should compare types of digital technologies components (to sense, to act, to represent the place);

- Outcome 8: the architects should justify the use of each IT component in terms of their contributions to the solutions of conflicts, eliciting their influence over topological characteristics such as interiority/exteriority, visibility and appropriation;

- Outcome 15: the architects should criticize the solutions designed to provide feedback to the theory.

All of those non-achieved outcomes are evidence that there was a need to reinforce the correlations between the generic functions of digital technologies components that could be potentially used to perform in conjunction with a place's physical characteristics, such as interiority/exteriority, visibility and appropriation. Thus, to investigate the correlation between IT and place, the four qualities were considered in terms of the requirements for the spatial phenomenon specified in the fundamental constitution of place, as interiority/exteriority, visibility and appropriation. Therefore, digital technologies components, analysed according to topological elements of place, were described in terms of potential use, affecting interiority/exteriority, visibility and appropriation, being linked to the four qualities of territoriality, privacy, identity and ambience.

		Territoriality	Privacy	Identity		Ambience
		Interiority / exteriority	Visibility	Visibility	Appropriation	Appropriation
Section A: **Components to Sense the place**	Microprocessors					
	Sensors					
	Tags					
	Communication links					
Section B: **Components to act in the place**	Actuators					
	Processes of control					
	Displays					
Section C: **Components to represent the place**	Fixed locations					
	Software models					
	Tuning					
Section D: **Place Components**	Enclosure					
	Horizontal directions					
	Vertical directions					
	Centrality					
	Internal Area					
	Entrances					

Table 18: Analytical Elements of Ubicomp relatively the place's qualities.

This was the process that led to the compilation of Table 18, mentioned in Chapter 3, section 3.6 on page 73, repeated above. By means of that table it is supposedly possible:

- To record and analyse an observed conflict according to how it interferes with qualities such as territoriality, privacy, identity and ambience, by discriminating between the physical situations related to that interference, such as interiority/exteriority, visibility and appropriation.

- To interpret which digital technologies components can be efficient when it comes to improving phenomena like interiority/exteriority, visibility and appropriation, interpreting how components to sense, to act and to represent the place can affect the qualities.

To analyse how the components of place (enclosure, horizontal directions, vertical directions, centrality, internal area and entrances) are related to the aforementioned affected qualities and to their physical expressions, such as interiority, visibility, and appropriation. This should permit analysis of a place in terms of its topology and help to decide how its components could be modified, recast or refurbished so as to solve a detected conflict in conjunction with one or more of the digital technologies components specified.

Chapter 8:
Discussion and Evaluation

Chapter 8: Discussion and Evaluation

It will be useful to summarize what has been seen so far in this research in order to give the fundamentals upon which to base a discussion of the findings of the case-studies. Initially, in the Introduction, key questions concerning the development of a framework focusing on the design of Ubicomp in urban areas were established. A real situation as experienced through the Gwangbok Project was the starting point which revealed a lack of appropriate conceptual tools to support architects and urban designers in the design of Ubicomp solutions to problems in urban areas. That initial problematic situation led to a review of the state of current knowledge concerning technology, space and society in Chapter 1.

Introducing a discussion about the relationship between space and information, Chapter 1 established some important points to help the theoretical development of the framework. The relation between activities and information were detailed through the lens of social studies, discussing the broad correlations between technology and society and observing their mutual influences. By concluding that the need to establish a distinctive approach to the understanding of information that was suitable to architects, the discussion moved on to the analysis of the nature of information. Thus, after analysing the nature of information in light of the idea of *Biological cognition* (Maturana 1980), the environment was regarded as a set of events which mutually cause and receive interferences from the human activities; these were characterized as mutual *"disturbances"* in the structural organization of both the space and the activities. Thus, instead of considering information as something that conveys symbolic representations of the world carried from an emitter to a receptor, it came to be regarded as all manner of disturbances through which the systems coordinate their performances in order to generate consensual and co-operative actions to support themselves. Through this point of view, the environment was observed as being itself the concrete expression of useful information. The built environment was, on this analysis, an expression of the linguistic domain which, through its concrete organization, propitiates communicative interactions among activities and spatial elements. This insight was at the core of the framework, the content of which was scrutinized in Chapter 2.

An initial idea of place was introduced in Chapter 2, and, adapting the views of Malard (1992), its qualities were characterized as existential phenomena. After correlating the idea of place to the concept of equipment, it was observed that activities and spatial elements could be in conflict, thus occasioning disturbances that require modifications to be made. A technique for reading those conflicts was presented as a useful tool for architects, since the interferences caused by the conflicts with the place's qualities would be clearly visible in terms expressed by missing spatial elements or conditions and the affected qualities. Thus the framework focused on the topology of the place, observing the qualities of territoriality, privacy, identity and ambience related to topological

elements described as enclosure, internal area, internal area, horizontal/vertical directions, centrality and entrances. Once again, each topological element was associated with some physical condition related to the qualities, such as exteriority/interiority, visibility and appropriation. Following this, Chapter 3 introduced the digital technologies components, classified according to their functions in the place, and they were also described in terms of their potential relationships to those aforementioned physical conditions (exteriority/interiority, visibility and appropriation). Therefore, they were related to the qualities of the place that permitted their association with physical solutions in order to reinforce those qualities. A final summary of the concepts was expressed in the format of a table of concepts which could be used as a guide by architects in their analysis. Once the theoretical framework was developed and presented, the next step was to consider how the framework could be tested through an appropriate methodology. This was central to the discussion laid out in Chapter 4.

The methodology adopted was the multiple-case study method, since that method was considered the most appropriate way of testing the framework in its theoretical stages of development. Through the analysis of the key questions of the research and considering the framework actually developed, a total of fifteen expected outcomes were generated so as to permit a proper evaluation of the results when the framework was used to support architects in their projects. Three case studies were then carries out: Gwangbok (2005), Fargate (2006) and the Campus project (2007).

Chapters 5 to 7 introduced the cases by describing the problems identified in each situation and presenting the solutions provided by the architects. Thus, following on from this, each case was evaluated on the basis of the fifteen expected outcomes, taking care to observe whether those outcomes were achieved, partially achieved or not achieved at all. Now, in this chapter, those cases taken as a whole will be discussed further.

8.1. Particular characteristics of the cases

Some particularities should be emphasized when considering a discussion of each case individually. Such particularities were obtained during the Gwangbok Project, of which the present research investigator was a participant, and during the reviews conducted of the Master's course module, when the behaviour of the architects was actually observed. Those particularities may help the understanding of some outcomes when they come to be discussed individually.

First, the Gwangbok project was one of the solutions that, together with Fargate, would demand the greatest level of physical intervention in order to be completed. In spite of the architects having declared that the use of IT should actually reduce the level of physical intervention required, the project did indeed needed portals, towers and other physical recasting, and these, in fact, turned out to be expensive ways of providing solutions to the identified problems. The problems, turning turn, were inferred from the observation of data sent by the city council, and which proved to be perfectly adaptable to the methods of conflict identification outlined in the framework. However, the problems were identified on the basis of the identification of just one specific problem to be solved by IT: those situations that interfered with local Identity. Thus, digital technologies components were thought to reinforce only that quality, whereas the other qualities would be improved by means of traditional physical refurbishment. This insight came specifically from the idea that the architects had at that time which was that IT could characterize a place by giving it identity by just simply performing a role as an interactive visual spectacle. Many antecedent projects were similarly concerned with such artistic skills in the creation of some transient

installations of IT in buildings and places, such as those in the projects of Lozano-Hemmer (2005) and Toyo Ito (Puglisi 1999).

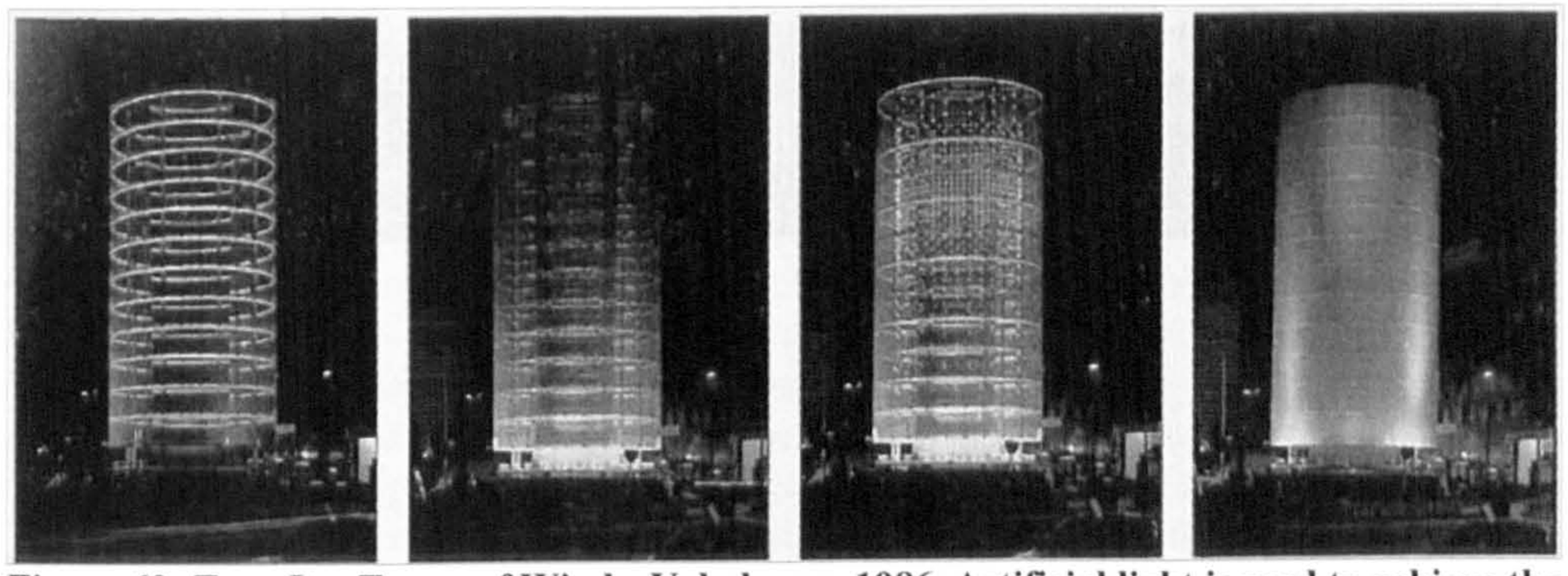


Figure 69: Toyo Ito. Tower of Winds, Yokohama, 1986. Artificial light is used to achieve the continuous transformation of the building's appearance.

Figure 70: Lozano-Hemmer and his "*relational architecture*": interactive light sculpture in the sky of Dublin, 2004.

But that experience revealed, after the project, that there was a lack of appropriate language that could be used in reflecting on solutions that could broadly cover the place as a whole, to address the improvements of those characteristics that are related to its inhabitability. Also, the identification of conflicts using the technique adapted from the work of Malard (1992) was only weakly adopted, and did not prove helpful in providing any insights greater than the use of the visual functions of gadgets to achieve some identity.

The same misuse of the method in the identification of conflicts can be observed in the solutions provided for Fargate. Participatory observations revealed that the architects, after having received a report of the conflicts existing in Fargate Street in a ready-to-use form ignored that list of conflicts, interpreting the solutions in terms of IT gadgets 'anchored' in the place. Therefore, once again, expensive refurbishment was introduced in order to support all the digital technologies components suggested. The graphical presentation of the project does not clarify the existence of any correspondence between the spatial elements provided and the conflicts which they are helping to solve. This was probably a result of the unexpected behaviour of the architects. The pedagogical intention was that, once the architects got the framework providing a list of conflicts and a classification of the relationship between IT and human experience (as *embodiment, hermeneutics,*

alterity and *back grounded relations*; see on page 241), the architects would be inspired to create meaningful correlations between IT gadgets and spatial elements, thus assembling components of IT *meaningfully* with proper reference to the space. The concepts concerning the types of relationship with technology were adapted from the work of Don Ihde (1990) and were an attempt to adopt the idea of a theory that sees mutual influences at work between activities and space, society and built places. It was expected that, for example, some analogies with the so-called *hermeneutic relations with technologies* could help in the creation of gadgets that would be able to translate the significance of Fargate Street into connected representations in the form of displays using signals, maps, and even physical elements. As another example, *back grounded relations* could be established by means of automatic servomechanisms such as foldable canopies along the pavement, that would open every time it starts to rain. Thus, pedagogically speaking, it was expected that the architects could enrich those concepts with examples from their solutions. However, this did not happen. In the Fargate Street Project, this only occurred indirectly; it was only after examining the drawings, that the solutions could be related to the intention to solve the identified conflicts. Observing the architects during the review, it became clear that their justifications for the solutions offered were imagined in a manner that was very abstract, and extremely difficult to grasp during the routine design process. Also, their skills in referring to digital technologies components and competently dealing with their functions were low. As has been shown in Chapter 6, the project requested expensive refurbishment, and solutions using systems of IT through mobile gadgets did not exist.

The third case, the Campus Project Case was composed of two groups, and it is possible to verify differences between them, in terms of achieved outcomes. Group I achieved 7 outcomes whereas Group II achieved only 2. Group I did not achieve 3 of the 15 outcomes and Group II did not achieve 7 of the 15 outcomes. This means that Group II failed to achieve almost half of the expected outcomes, whereas Group I obtained only a little more than Group II by achieving these outcomes partially. With participation in the review process, it became possible to say that the Master's Course module Group II had problems when it came to getting together to work in group. At least this is what the students alleged in order to justify the lack of information provided about their solutions, and this was reflected in the impoverished nature of the solutions outlined in the drawings and rationales.

8.2. General Characteristics of the cases

In order to study the general characteristics of the cases, it will be helpful to contrast the results obtained by comparing the expected outcomes with the actual outcomes for each project that used the framework. With the aiming of helping the reader, it is worth mentioning once again that the expected outcomes used in this evaluation were derived from the key research questions. These were made up of 15 enunciations based on the taxonomy outlined by Bloom (1956) and resulted in the following statements:

By using the framework in the project, the architects will be able to:

1. Explain the qualities of place in terms of Territoriality, Privacy, Identity and Ambience.

2. Explain the topology of the elements of place in terms of centrality, enclosure, internal area, internal directions, and entrances.

3. Given a place, identify the conflicts between spatial elements and activities in places and elicit how they interfere in the qualities of place.

4. Compare types of digital technologies components (to sense, act, and represent the place).

5. Explain the topology of digital technologies components and its potential interference with the place's qualities (explain the correlations between interiority/exteriority, visibility and appropriation and the functions of the digital technologies components).

6. Create solutions to the identified conflicts by using digital technologies components and spatial elements.

7. Implement the IT solutions as an integrated part of the place's topology.

8. Justify the use of each IT component in terms of the contribution made to the solutions of conflicts, eliciting their influence over topological characteristics as interiority/exteriority, visibility and appropriation.

9. Plan the IT system together with physical interventions that will help to solve the detected conflicts.

10. Plan physical changes to support the IT system planned.

11. Specify the spatial requirements for the IT system adopted.

12. Plan schemes of IT systems, such as gadgets to be used in the place.

13. Specify the digital technologies components and gadget functions in the system so as to permit exchanges with other fields such as computing sciences.

14. Justify the solutions adopted, clarifying the accomplished advantages.

15. Criticize the solutions designed in order to provide the theory with feedback.

Describing the results and comparing them by application, it is possible to create Table 29 which represents the 3 cases with the 4 applications.

Legend: A: outcome achieved; PA: outcome partially achieved; NA: outcome not achieved.

	Case I			Case II			Case III					
Projects	A- Gwangbok			B- Fargate			C- Group I			D- Group II		
Achievement /expected outcome	A	PA	NA	A	PA	NA	A	PA	NA	A	PA	NA
Outcome 1		X				X	X			X		
Outcome 2			X			X	X					X
Outcome 3		X			X		X			X		
Outcome 4			X			X			X			X
Outcome 5			X			X		X				X
Outcome 6		X			X			X			X	
Outcome 7		X			X		X				X	
Outcome 8		X				X			X			X
Outcome 9		X			X		X				X	
Outcome 10		X			X			X			X	

Outcome 11			X			X		X			X	
Outcome 12			X			X	X					X
Outcome 13		X				X	X				X	
Outcome 14			X			X		X				X
Outcome 15			X			X			X			X
total	0	8	7	0	5	10	7	5	3	2	6	7

Table 29: Comparison between cases: outcomes achieved

Again, focusing on the previous table, it is possible to separate, over the whole experiment, the number of outcomes achieved, partially achieved and not achieved at all. They are spread across the individual cases as follows:

Legend: A: Gwangbok; B: Fargate; C: Campus, group I; D: Campus, group II.

Outcome	Achieved				Partially Achieved				Not Achieved				
	A	B	C	D	A	B	C	D	A	B	C	D	Total of **not achieved**
1			X	X	X					X			1
2			X						X	X		X	3
3			X	X	X	X							0
4									X	X	X	X	4
5							X		X	X		X	3
6					X	X	X	X					0
7			X		X	X		X					0
8					X					X	X	X	3
9			X		X	X		X					0
10					X	X	X	X					0
11							X	X	X	X			2
12			X						X	X		X	3
13			X		X			X		X			1
14							X		X	X		X	3
15									X	X	X	X	4
total	0	0	7	2	8	5	5	6	7	10	3	7	

Table 30: Comparison of outcomes achieved, partially achieved and not achieved.

Observations of the two tables reveal a clear representation of the percentages of the outcomes fully achieved, partially achieved and not achieved at all in each case and application. Thus, according to the following charts:

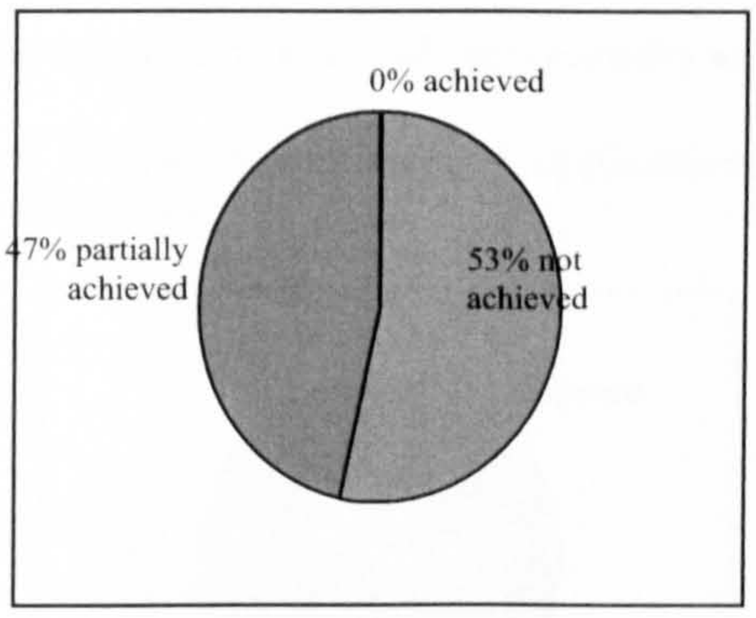


Table 31: Case Gwangbok Street Project; 0% achieved, 47% partially achieved and 53% not achieved

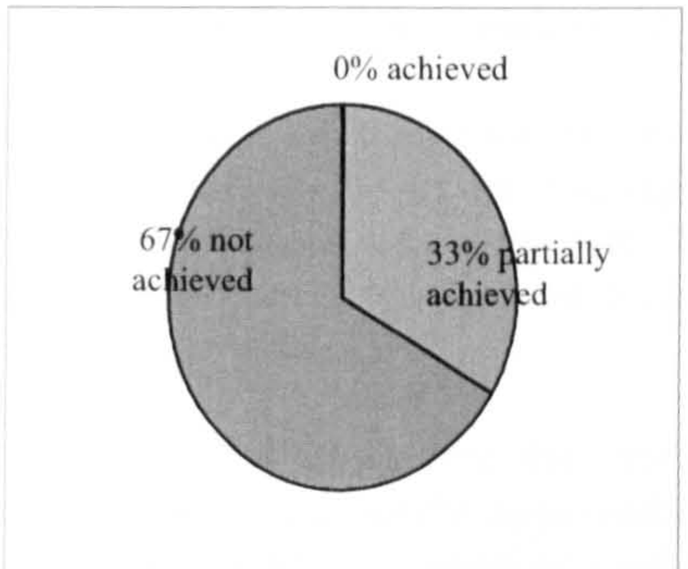


Table 32: Fargate Street Project; 0% achieved, 33% partially achieved and 67% not achieved.

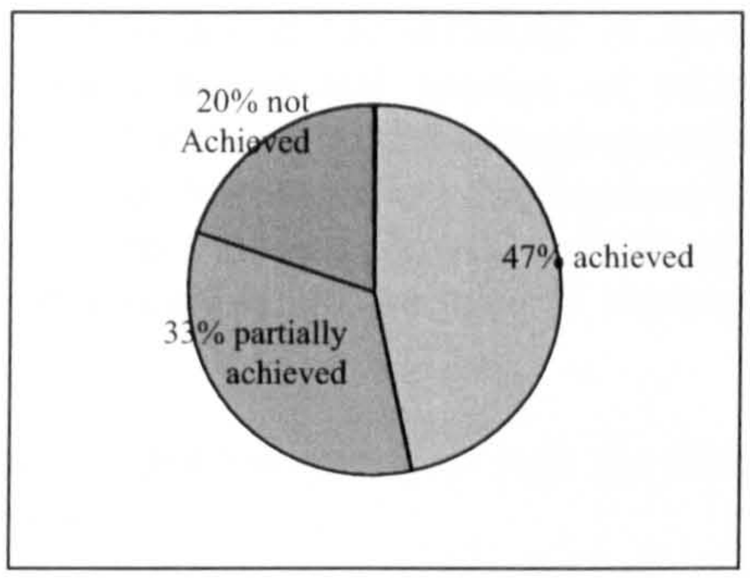


Table 33: Campus Project, Group I: 47% achieved, 33%partially achieved and 20% not achieved.

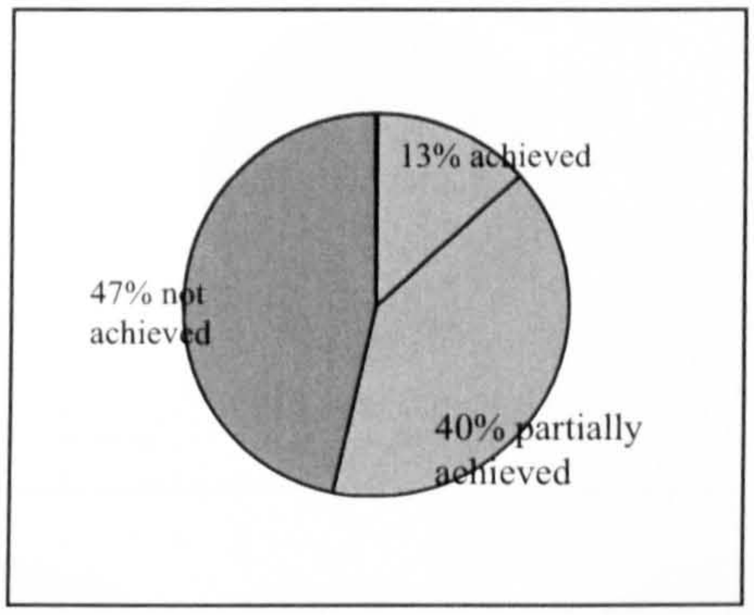


Table 34: Campus Project, Group II: 13% achieved, 40%partially achieved and 47% not achieved.

Thus, representing a total of 60 outcomes in the 4 applications, the representation of their achievement in the 3 cases is as follows:

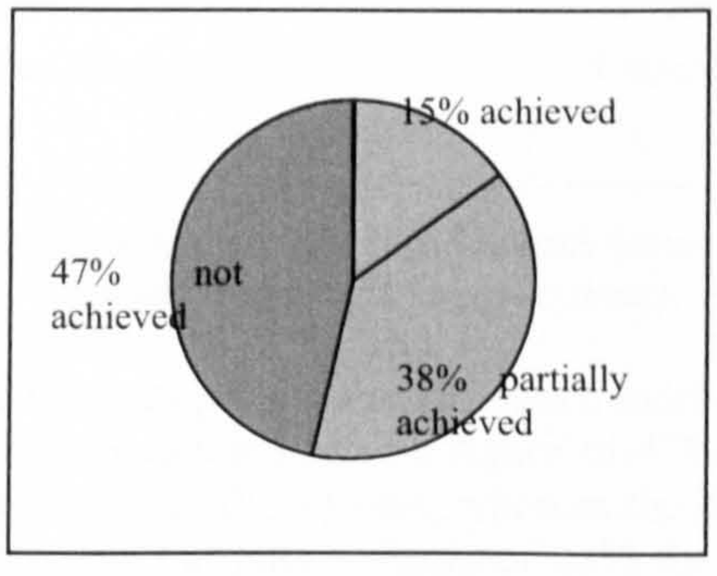
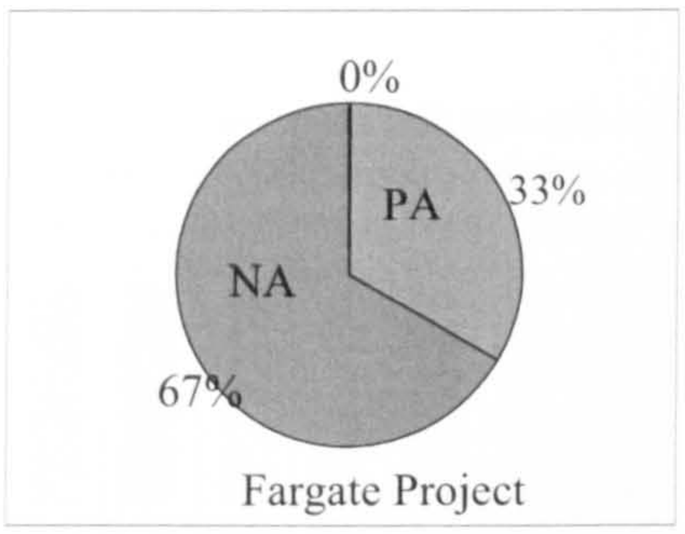


Table 35: Total of outcomes achieved in 4 applications of the framework.

This last graphic represents the percentage of outcomes achieved, partially achieved and not achieved with respect to four applications, including the Gwangbok Street Project, the Fargate Street Project and the Campus Project. Not much information can be deduced from this graphic. It does not reflect the improvement in the framework since it includes the Gwangbok Project, at which point a proper framework was not in place.

Analysing the earlier graphics, it is possible to observe that from the Gwangbok Street Project (2005) to the Fargate Street project (2006), the results apparently show that the achievement of outcomes had worsened. In fact, Gwangbok Street cannot be compared, as has already been said, since at that time there was no framework but instead merely conceptual rudiments that had not yet been placed inside a theoretical structure. Even so, the Fargate results were worse than those for Gwangbok. This comparison only points to the difficulty in developing consistently structured framework, coherently consistent with the real practice of architects during the project and considering a conceptual approach that would explain the phenomenon. It is particularly worthy of attention because it reflects the use of the theoretical development based on the work of Don Ihde (1990), whose concepts concerning the relationship with technology were very weak when it came to inspiring the architects to produce correlations between IT components and place elements in the project.

Comparing the results from the Fargate Street Project with the Campus Project, the charts below permit an understanding as follows:



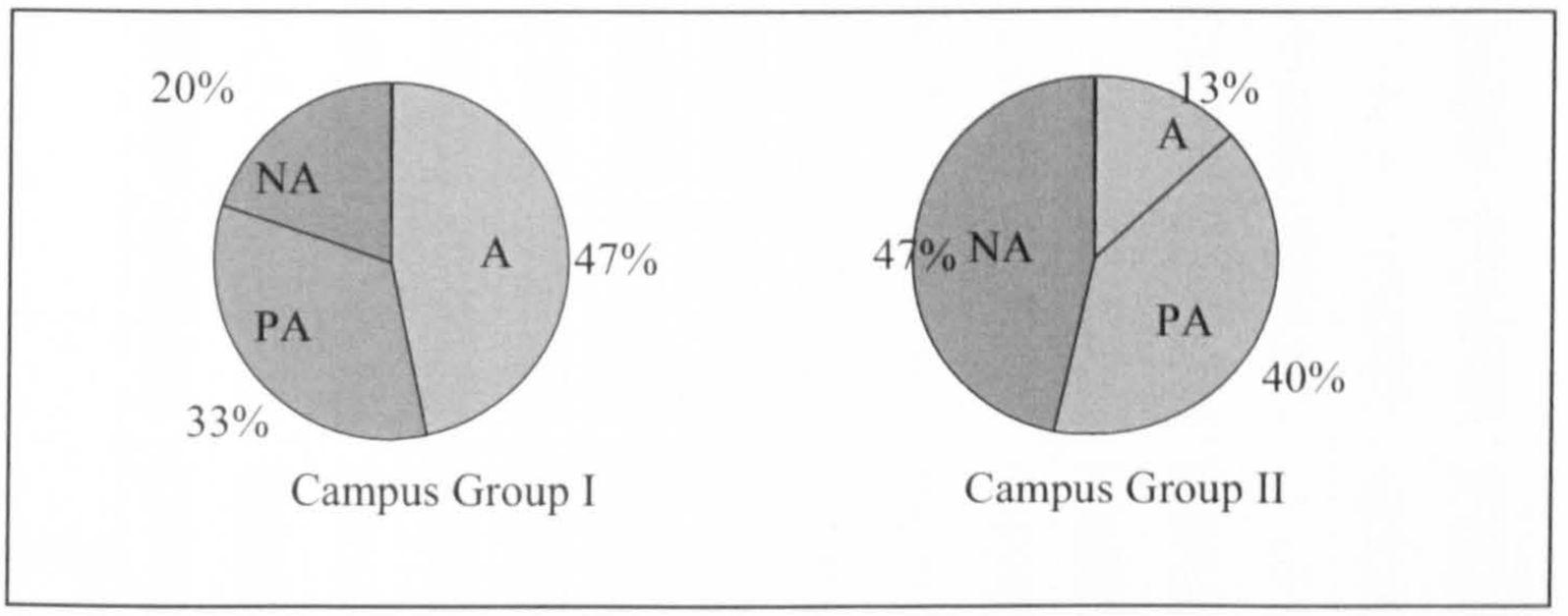


Table 36: Comparison of outcomes achieved between Fargate Street Project (one application) and Campus Project (two applications).

As can bee seen, the case of the Campus project shows a much more efficient result associated with the framework. The number of outcomes indicates a figure of 47% for achieved ones in the first group and 13% of outcomes achieved in the second, whereas the Fargate Project did not present any instance of an achieved outcome, but only a figure of 33% for those partially achieved. Both

groups I and II have similar percentages with respect to outcomes partially achieved, from 33% for group I and 40% for group II. It was mentioned that group II alleged the existence of particular problems among participants when it came to working together, which interfered with the results, but even so, the results were better than those for the Fargate Project.

On average, 36% of the outcomes were achieved in the case of the Campus Project in comparison with the Fargate project. This average was calculated as a simple average from the results for the two groups, and considering that the Fargate project did not achieve any outcome completely.

This simple analysis permits some conclusions to be drawn about the framework developed, in light of results compared in sequences that correspond to amendments to the framework. On the basis of such results, it is reasonable to say that the framework improved the results of the Campus project significantly, by at least 30% in comparison with two of the cases (Fargate and Gwangbok).

The large number of outcomes that were either partially or not achieved at all must be also considered. But, before coming to conclusions about those data, it will be useful to analyse the performance of the cases according to each outcome.

8.3. Qualitative view of the outcomes

A graphical representation of the outcomes assessed and afterwards categorized on the basis of three types according to the evaluation (achieved, partially achieved and not achieved) were presented previously in Table 29 and Table 30. Now, they can be expressed by the following chart:

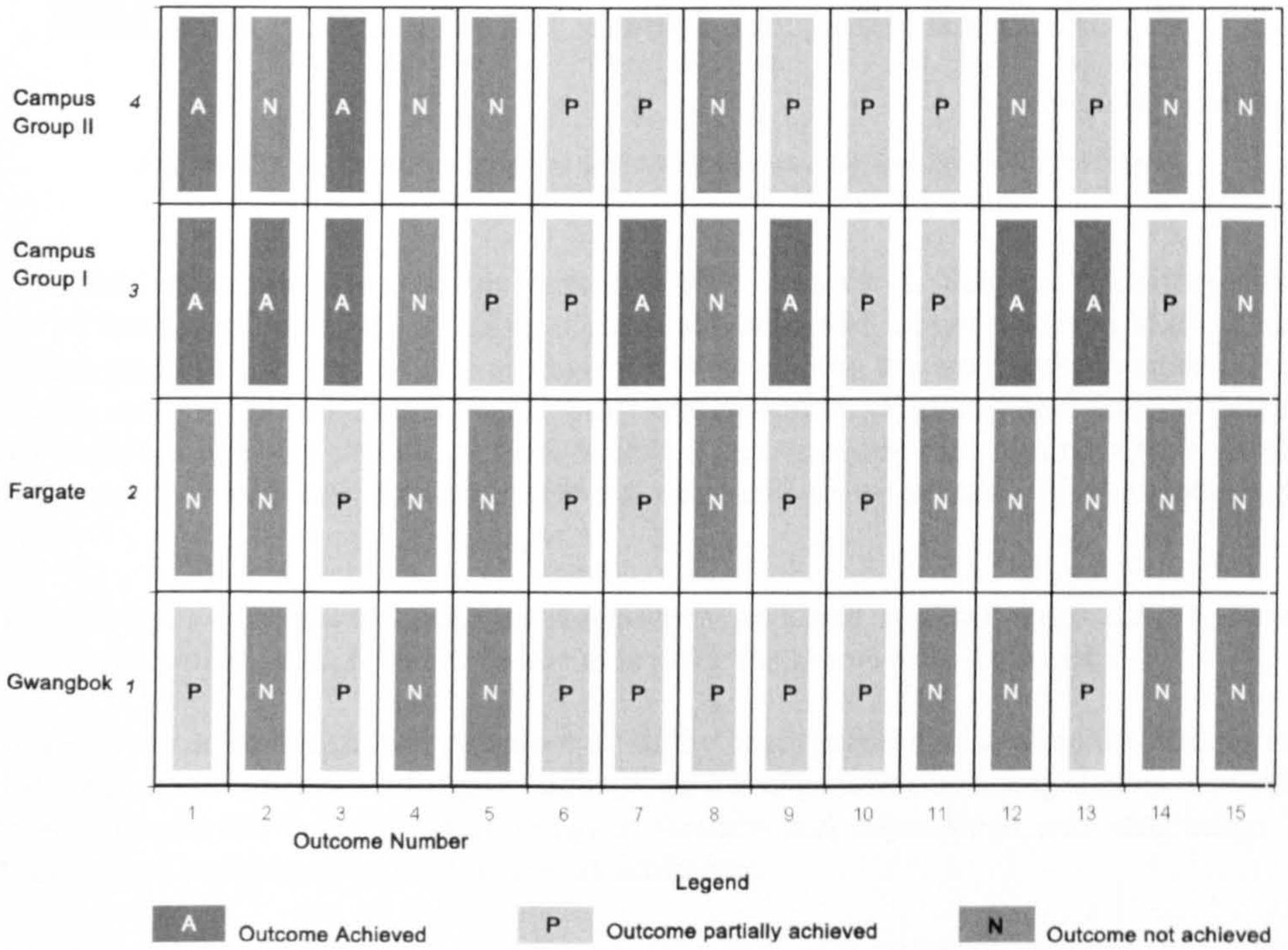


Table 37: Graphical representation of tables 29 and 30.

In this graphic, each "*slot*" represents an outcome evaluated (the category for which is represented by the colours) in the four projects that the three case-studies deal with. The four projects are represented in axis Y (Gwangbok, Fargate, Campus Group I, Campus Group II, those latter instances from the same case). There are thus 60 "*slots*" which represent the 4 times the 15 outcomes were assessed

.

These representations can be translated into

, in order to analyse each outcome individually, case by case. Thus, the following table expresses the outcomes according to their achievement exactly as it does in the previous table:

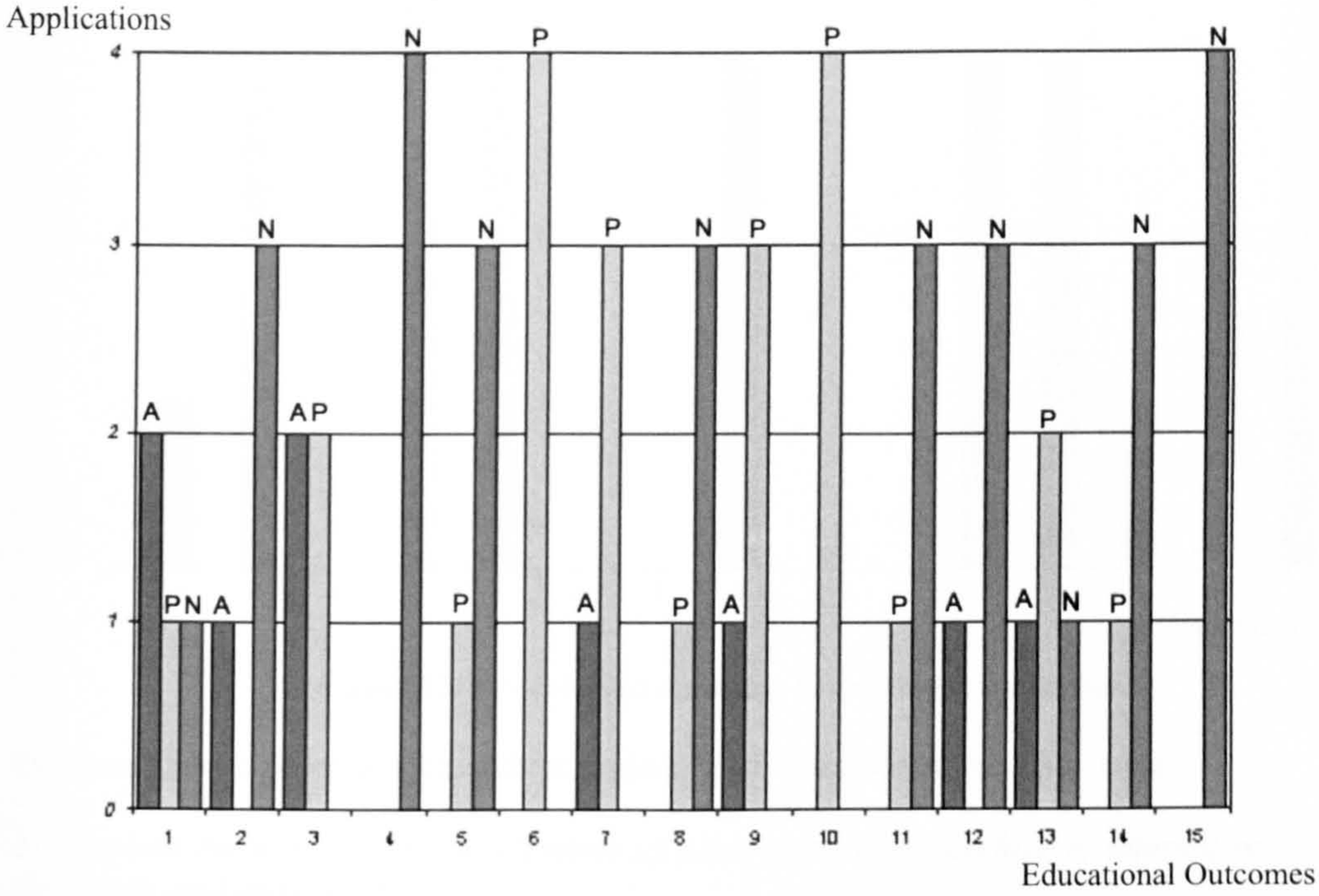


Figure 71: Outcomes and their achievement one by one in 4 applications; A: achieved; P: partially achieved; N: not achieved.

This new table represents the outcomes from 1 to 15 in the axis X. The axis Y corresponds to the numbers of times that outcome was achieved, partially achieved, or not achieved at all. Since there were 3 case studies in which and one of those got two projects, the maximum number in axis Y is 4. For each category of outcome a colour has been indicated. *Achieved outcomes* are green. The *partially achieved* ones are yellow, and *not achieved* outcomes are red. By this simple graphic it is easy to deduce that outcomes 4 and 15 were not achieved in any instance. They correspond to the statements:

4. *Compare types of* digital technologies components *(to sense, act, and represent the place).*
15. *Criticize the solutions designed in order to provide the theory with feedback.*

The failure in the achievement of outcome 4 in all the cases permits us to conclude that there is the need for a better classification of digital technologies components, in a way makes it possible for architects to handle the variety of technological features and expressions with simplicity. This is one of the central problems that the framework addresses.

The failure to achieve outcome 15 corresponds to a lack of a criticism, evidence for which was observed neither in the rationales nor in the review sections. This was possibly caused by the fact that the projects' briefs and the course outline did not provide clear enough information about

criticism, simply failing to ask for it at all. The conceptual platform created by group II could be considered a reaction to the narrowing constraints imposed by the framework, but even so this does not constitute a criticism.

Other considerations can be inferred by observing other *outcomes not achieved*:

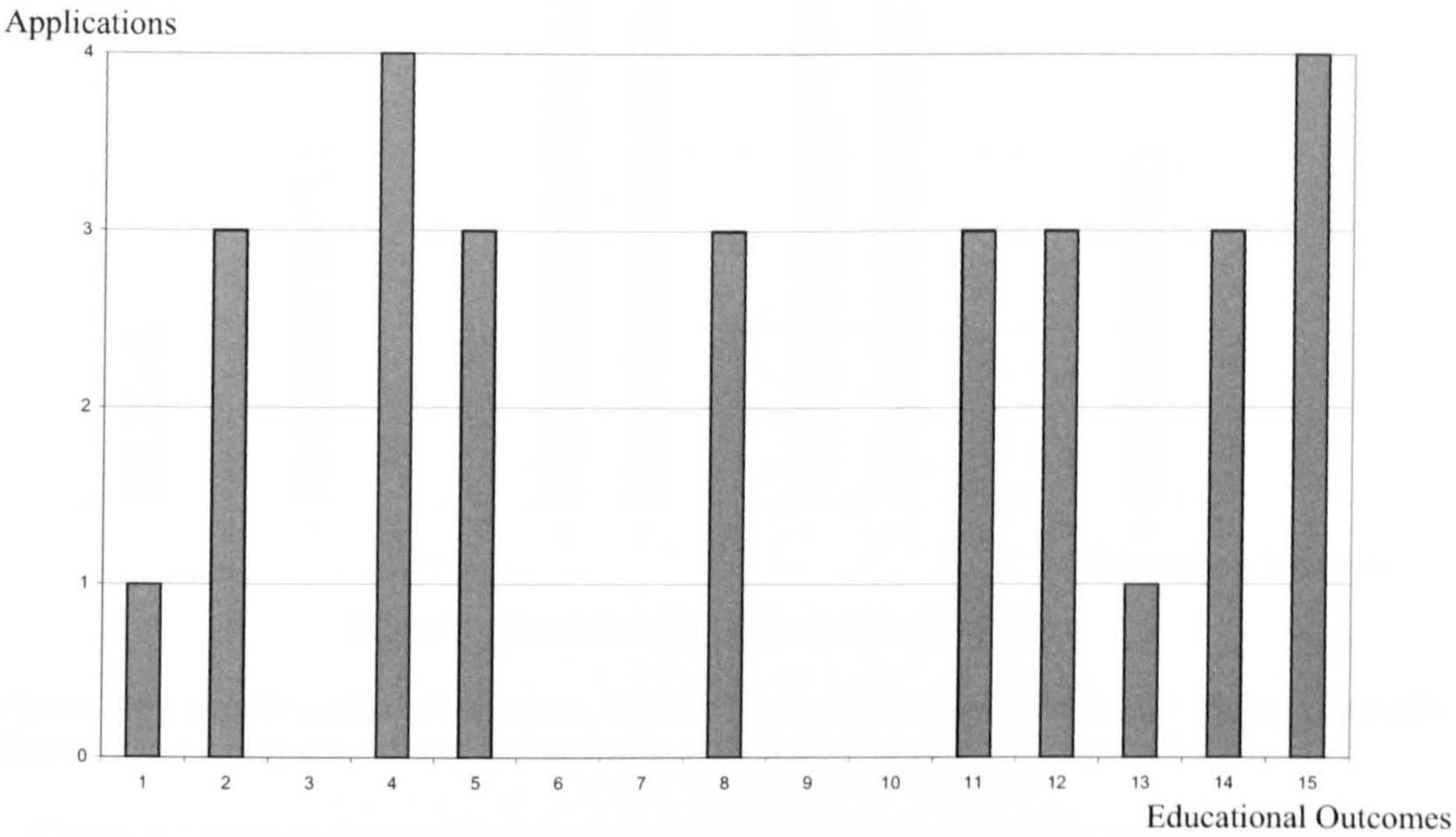


Figure 72: Not achieved outcomes in the three case studies.

Outcomes not achieved in at least three projects have called attention. They were:

2. Explain the topology of the elements of place (centrality, enclosure, internal area, internal directions, and entrances).

5. Explain the topology of digital technologies components *and potential interference of it over place's qualities (explain the correlations between interiority/exteriority, visibility and appropriation and the functions of the digital technologies components).*

8. Justify the use of each IT component in terms of their contributions to the solutions of conflicts, eliciting their influence over topological characteristics as interiority/exteriority, visibility and appropriation.

11. Specify the spatial requirements for the IT system adopted.

12. Plan schemes of IT systems, such as gadgets to be used in the place.

14. Justify the solutions adopted, clarifying the accomplished advantages.

Analysing those outcomes, it is possible to say that they refer to subjects that were only completely developed and accomplished by the framework's amendments which were done after the occasion of the Fargate Street Project. Those subjects included the topology of place regarded together in correspondence with the topology of digital technologies components, focusing on properties such as *interiority/exteriority, visibility and appropriation*. They also provided the impetus for the last amendment to the framework which has not yet been tested.

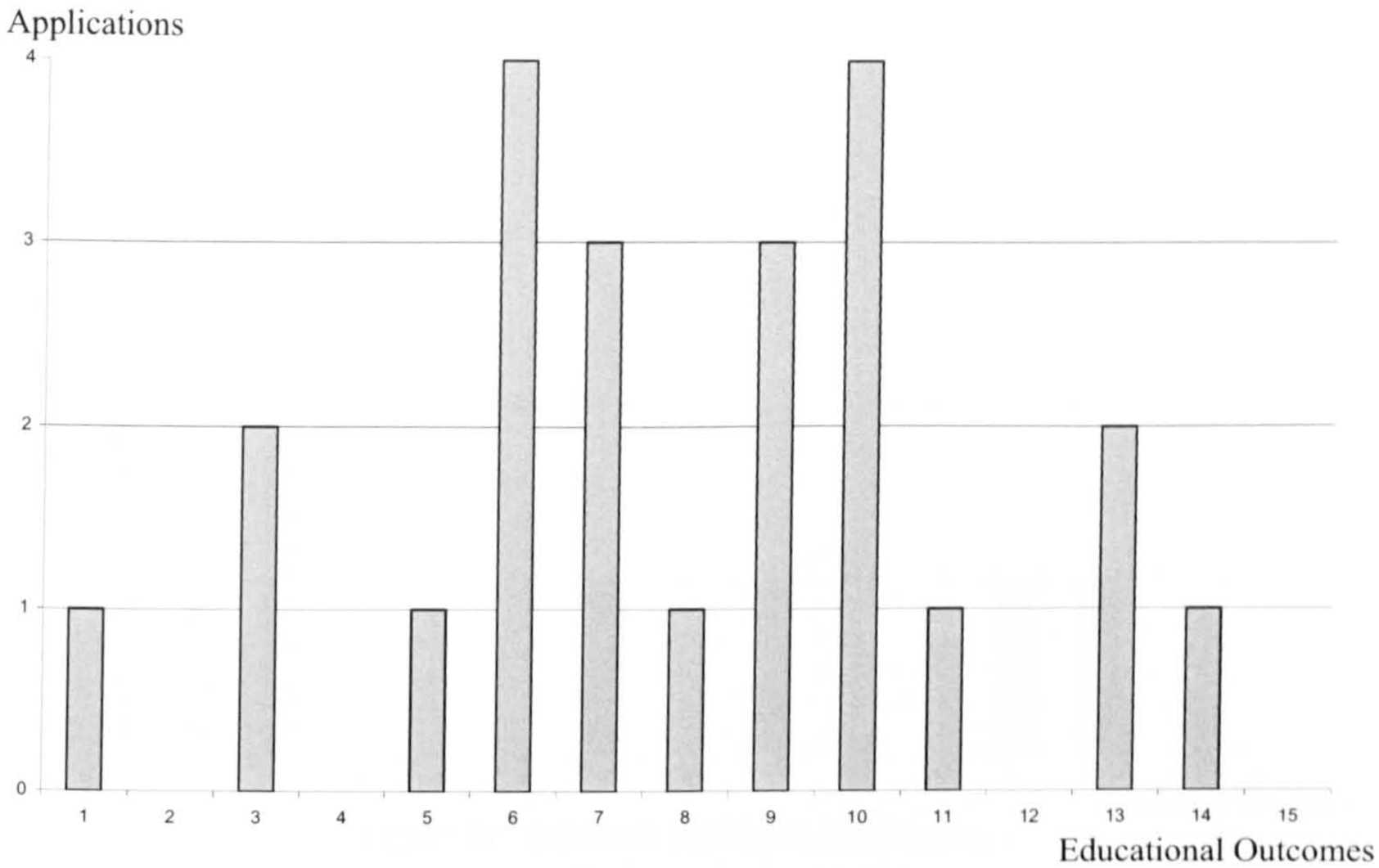


Figure 73: Partially achieved outcomes, in all cases.

In terms of *partially achieved outcomes*, Figure 73 shows that outcome 6 and 10 were partially achieved in all 4 projects outlined in the 3 case-studies:

6. Create solutions to the identified conflicts by using digital technologies components and spatial elements.

10. Plan physical changes to support the IT system planned.

Both outcomes focused on the full ability to manage IT in the creation systems integrated with space. Since the projects failed at some point or other by offering conditions to consider those outcomes fully achieved, they are necessarily hard to get.

Finally, an analysis of the *achieved outcomes* shows that outcomes 1 and 2 were achieved in the final two applications outlined in the third case study.

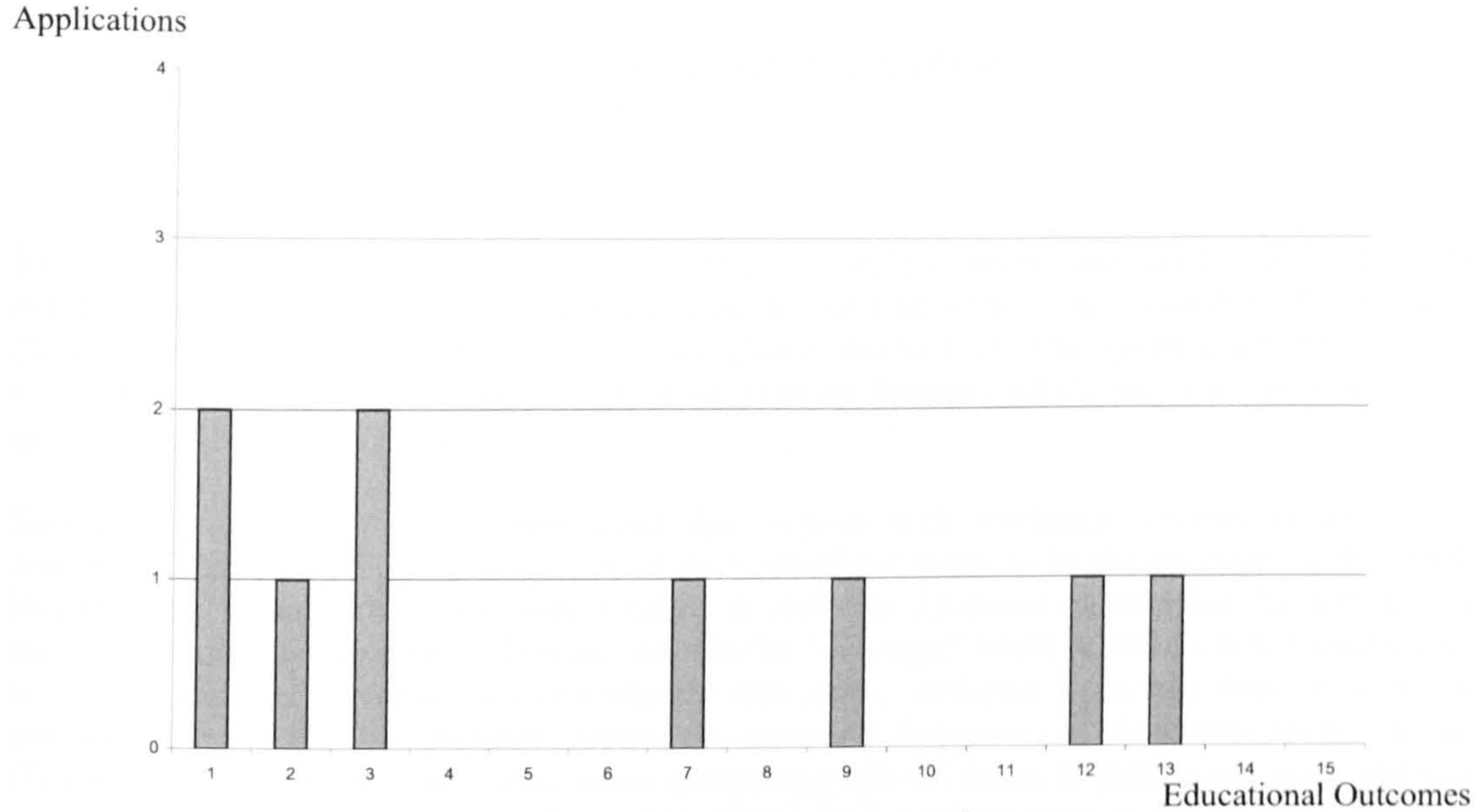


Figure 74: Achieved outcomes, in all cases.

1. Explain the qualities of place (Territoriality, Privacy, Identity and Ambience).

3. Given a place, identify the conflicts between spatial elements and activities in places eliciting how their interferes over the qualities of place.

The other achieved outcomes happened only in the group I of case of Campus Project, and they were:

7. Implement the IT solutions as integrated part of place's topology.

9. Plan the IT system together with physical interventions that will help to solve the detected conflicts.

12. Plan schemes of IT systems, such as gadgets to be used in the place.

13. Specify the digital technologies components and gadget functions in the system so as to permit exchanges with other fields such as computing sciences.

All those latter outcomes are very important inasmuch as they permit the potential of the framework to give architects the support asked for in the initial key research questions to be observed. At the same time, this data can be interpreted as the highest level of achievement of the framework; no matter whether it happens to be referring to just one project (Campus project group I). As was pointed out throughout the whole of Chapter 4, the cases did not focus on a universe but rather on specific situations. The projects of the architects that were observed did not constitute 'populations' that were amenable to the traditional statistical treatment of colleted data. That means that the exhibition of tables and other comparative operations should be always accompanied with appropriate reasoning and with due consideration given to the whole context in order to provide a valid qualitative interpretation of the data. In the next subsection, however, some inferences will be traced that will consider the aforementioned data, in order to arrive at a quantitative approximation.

8.4. Quantitative view of the outcomes

In the evaluation of educational outcomes it is common to consider the number of students as a population from which grades achieved can be marked on axis Y as a number of occurrences (frequencies), whereas axis X represents the grades themselves. The graphic generated by this configuration will depict the occurrence of frequencies through which the students achieved the grades, from zero to the highest.

Similarly, with respect to all phenomena that behave with tendency towards an average, in educational terms, the highest frequency in such situations tends to be the average for the grades, its arithmetic mean. This distribution is called in statistics *a normal distribution*. This means that most of the examples in a set of data are close to the "*average*," while relatively few examples tend to one extreme or the other. To characterize this curve, deduced from real data, it is defined statistically that a standard measure, named the *standard deviation* can show how spread the data (frequencies) are beneath the curve, when comparing two of them. In Education, such statistical analysis allows more information about classes and their performances to be obtained. With this statistic tool, it is possible to reason on how to modify pedagogical strategies and also how to modify certain educational outcomes. The standard deviation gives information about the context for the total number of students, when regarding a frequency in the graphic.

In Figure 75, the hypothetical results of a class are exemplified. By analysing these, it can be said that a large number of students achieved low grades, and this can reflect a bad performance resulting either from the students themselves and their social milieu or by the method adopted for the evaluation itself. Both interpretations are possible. But on the basis of that graph, it is possible to say that the distribution was not normal.

The same situation can be seen in Figure 76, which can be interpreted as the students that obtained good grades according to the degree of normality (a normal pattern of distributions, slightly pushed to the high grades) which could be, inversely, interpreted as a result of a inefficient system of evaluation in which it was made artificially easy for the students to achieve the outcomes.

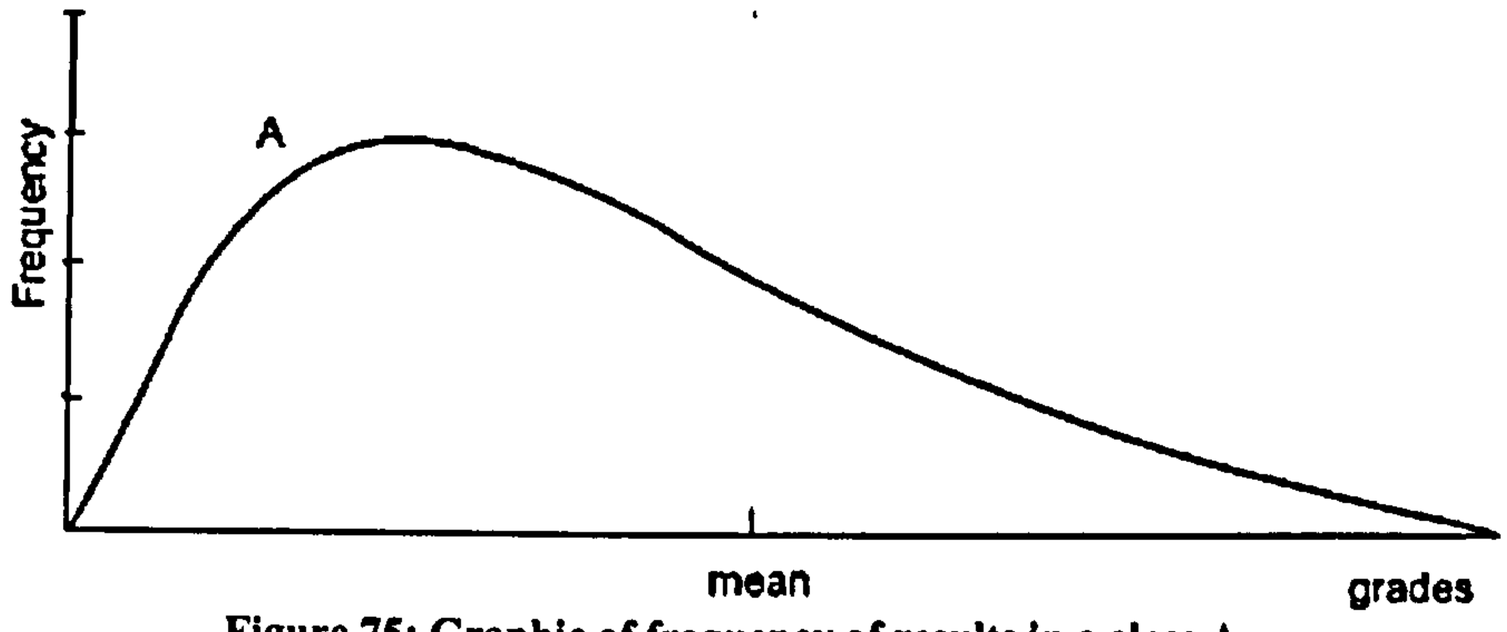


Figure 75: Graphic of frequency of results in a class A.

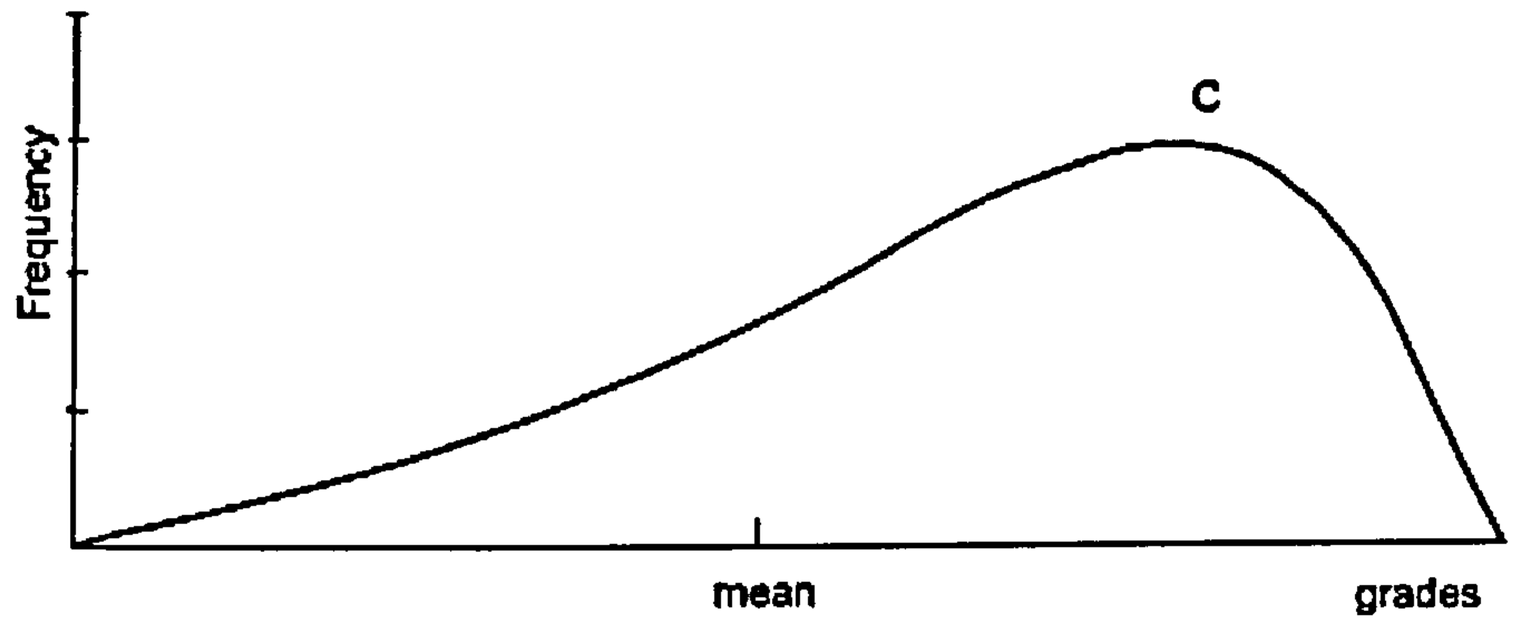


Figure 76: Graphic of frequency of results in a class C.

In one way or another, this brief account of the statistical treatment of educational outcomes was undertaken just for the sake of revealing the fact that, in terms of its evaluation there is a need for a qualitative analysis together with a quantitative approach - a reasoning with which to understand the graphics as the reflections of real practice. In the case of this research, it is impossible to undertake such analysis efficiently, since there were only three categories of assessment with which to divide the X axis (achieved, partially achieved and not achieved) in the 4 projects. Moreover, the research does not focus on the students themselves but on the resulting projects. However, a possible source of comparison would come about from observing the achievement of the outcomes indicated by the three criteria, in a graphic similar to the aforementioned statistical strategy. The Y axis would then refer to the number of achieved outcomes. An analysis of normality focusing on the educational outcomes of a class would ask for more accurate data so as to permit the inference of the sinus curve of the "normal" phenomena.

Finally, considering the 60 evaluations of outcomes from all the projects, as has been show in Table 37 on page 182, these can be distributed on the basis of frequencies thus allowing us to observe the outcomes assessed for all three cases and four projects. As may be noticed, those graphical shapes are similar to the shape of the curve shown in Figure 75. A possible interpretation of the similarity to that curve probably may be derived from the fact that the experiments gradually came to be supported by a more efficient framework, improved over the course of two years, which was able to result in more achieved outcomes. Another possible interpretation is that it is too hard to assess the projects in terms of the generation of expected outcomes through the framework, since it demands some skills that are possibly difficult for architects to acquire without proper training. Regarding this interpretation in light of previous interpretations of isolated outcomes, it could be said that the key difficulty for the architects was concerned with the use of a terminology suitable for referring to IT components in the design process, but at the same time based on criteria derived from the logic of *places* and their qualities, elements, and characteristics. The association between the means of referring to Information Technology with handling space itself lies at the heart of the conclusions that will follow next.

Conclusions and Future Research

Conclusions

In the course of the analysis of the various outcomes of the projects of the architects detailed in the last chapter, some specific topics related to the case studies were discussed. Those outcomes were derived from the key research questions and a model that explains levels of understanding (Bloom 1956) was used to classify the results expected, thus determining some of the educational objectives expected to be achieved when architects use the framework developed through this research. By analysing of those outcomes, the last chapter demonstrated the existence of some evidences that will now form the basis for the final conclusions and directions for future research.

The research has shown that it is possible to develop a reasonable theoretical approach to support architects in the application of IT to public places in early stages of design process. This approach relates knowledge of Digital Technologies components to the handling of the geometrical properties of public places. Since IT is correlated with the structure of the environment in a systematic manner, it could be said that by taking advantage of the topology of a place the proposed approach provides an '*embodiment*' for IT. Also, since place was considered to be a qualified portion of space - qualified by the relation between its activities and its spatial components - the use of IT was related to that process of qualification, and the theoretical framework has provided the means to justify the use of IT as part of that process of qualification. Thus, it was demonstrated that the contribution made by the framework could be fundamental to the study of IT embodiment as far as it concerns the qualification of spaces.

Throughout the development of the framework, IT was regarded as being able to improve the interactions between local activities and the spatial elements of the place concerned; that means, it was able to improve the interactions between people's activities and the physical supports required of those activities. The framework has significantly helped architects in the deployment of digital Technologies components as contributors to the improvement of the primary physical characteristics of a place, such as those processes that define the local interiority, control access to the exterior (visibility) and facilitate local activities by providing them with adequate physical support (appropriation). The last case study demonstrated that this approach was useful when it came to producing better results. However, these results should be viewed from a perspective if useful suggestions for future research are to be made.

The analysis of outcomes has shown that an average of 47% of the outcomes was not achieved in all case studies. However, this number decreased to 20% in the Campus Project for Group I.

Regarding cases II and III, where the framework was consistently applied, it is possible to consider that the average for '*not achieved*' decreased by at least 20% for each project where the framework was applied. Furthermore, the Fargate Project did not achieve 67% of the outcomes, this number was reduced to 47% for Group II, and 20% for Group I of the Campus Project. This permits us to conclude that a range of effectiveness of about 20% to 40% exists when the framework is used, with respect to the reduction of non-achieved outcomes. A similar analysis permits further conclusions when dealing specifically with achieved outcomes. Taking the same view as with the former analysis, the effectiveness of the framework was on average 15% better, considering the outcomes achieved in the three cases. The range was by 13% to 47% of achieved outcomes, in the Fargate and Campus projects. In short, it seems that the more the framework is tested and amended, the better the results become. The average of 38% corresponds to partially achieved outcomes in all cases, and it should be observed that future research should be undertaken in order to adjust the expected outcomes to the reality of what it is possible for architects to know about IT and digital technologies in designing new urban spaces.

Regarding the theoretical aspects of the developed framework, it is possible to conclude that it relies on a theoretical approach that considers place in terms of its physical characteristics, rather than mere abstract concepts, as often occurs when social studies are applied in architecture to study space and place. This research shows the importance of theoretical treatments of place as a spatial category and how the spatiality of place could be specified to be accessible to design activities. The development of the framework has shown that it was possible to correlate spatial elements, activities and the flux of information in a place through a paradigm that considers information as a pattern that represents a complex communicational phenomenon that exists in a given environment. By understanding information as '*disturbance*' (Maturana 1978), the physical elements of place came to be regarded not as if they conveyed information but rather as being themselves the communicated content. Thus, by this standpoint, the physical organization of the environment is regarded as the concrete expression of a linguistic domain. That linguistic domain comprehends the elementary interactions of people and space, interactions that happens during the process of qualification of the space. However, the term '*flux of information*' should be revised since this paradigm does not present the idea of information as an amount that can be transmitted, but rather as a simultaneous reaction to the systems in the built environment.

Correlations between spatial elements, activities and information were considered as being established by a topology that depicts, simultaneously, the structure of a place's elements and the structure of information in the place itself (see Figure 4 on page 32). Thus, definitions such as interiority, visibility and appropriation were observed through those components, which determine the qualities of territoriality, privacy, identity, and ambience. A '*disturbance*', in the sense used by Maturana's in his idea of biological cognition, means conflicts caused by the breakdown of spatial elements relative to the activities they conjugate and offer support.

The disturbances caused by the functional, technical or symbolic breakdown of spatial elements can be interpreted, through the model of the framework, as the moment when a lack of conditions to provide interactive and mutual support between activities and their appropriate spatial structure takes place. The heart of this framework is based on the idea that the use of technology can increase that interaction by using components that simultaneously affect the spatial structure and the activities associated.

Through the observation of its application by architects, it is possible to conclude that the developed framework is a tool of limited use in supporting projects that use IT components. Despite its systematic character, it relies on the idea that solutions should be *creatively* designed. That means that it neither parallels nor substitutes creativity, but it is supposed to inspire solutions through a more consistent analysis of the problems, as was observed during sessions of review undertaken with the architect students of the '*Interactive Urban Visualisation Modelling*' module.

Using the framework, the architects could organize their analysis of the place concerned, deploying components of digital technologies in the creation of solutions. In this sense, the framework is regarded as being particularly helpful at the earlier stages of projects, enabling decisions to be made on whether the project would contemplate the use of IT as solutions that would require less invasive physical intervention in the context of certain urban situations. However, direct knowledge about whether the solutions using IT would be less expensive than those that spurned it was not gained by this research. Despite this being an original concern, the focus of this inquiry was not in the end directed at the reduction of costs in urban refurbishment by means of providing less intrusive modifications through the use of IT.

The projects employing the latest version of the framework were more precisely described, justified and technically specified i.e. the two projects developed by Groups I and II in the Campus Project, presented in the case-study outlined in Chapter 7 on page 145. Those skills were observed in the last two projects where the outcomes achieved were about 47% and 15% of all the expected outcomes, in the Groups I and II respectively. It was inferred from the analysis of the outcomes that the interpretation of the IT components by means of their potential interference with the space, as was shown in Table 18 on page 73, is a crucial point in the process of analysis recommended by this framework. That table represents only a partial view of the technology, since it was classified in such a manner as to facilitate architects' decisions.

Finally, with respect to the question of whether the projects undertaken with the support of the framework ought to be considered better than those undertaken without any such support, it is certainly possible to say that the use of the framework provides a basis for a more coherent set of decisions regarding the use of IT in public places. However, it cannot be said with certainty that the projects would generally be better with the support of the framework. In order to assess such situations, projects with the same context should be analysed one by one and then compared according to some established criteria. The only general aspects that can be regarded as efficiently supported by the theory herein developed concerns the *logic* and *rationale* for the use of IT components i.e. as '*gear*' to support dwelling.

Future Research

Thus, according to the conclusions, regarding the methodology adopted in this inquiry, it is possible to infer that future research projects would be helpful in creating a more realistic set of expected outcomes, thus continuously refining the place-theoretical framework developed. This refining process should take in consideration educational outcomes formulated in the light of common activities that are taken in the profession of architects. This would help in the definition of professional abilities that eventually should be considered as specials skills, requiring training or specific formation.

Considering the wide range of studies that have addressed the subject place and space, this framework contemplates those kinds of theories that offer the means to establish correlations between space and information, and consequently IT components and place. The approach to the idea of place as implied by Heidegger's ideas was used, but with respect to many others key thinkers on space and place (Hubbard *et al.* 2004), future research could investigate further theoretical viewpoints, relating IT to diverse qualities that can be defined as qualities of place. For instance, how the structure of the space proposed by Norberg-Schulz (1971) as elements of

centralities, paths and areas could be used to consubstantiate with the topology of IT could be investigated. The importance of this framework lies in its conclusion that, whatever the theory of place used in future research, it should be concerned with spatial and physical properties so as to make meaningful associations between IT and physical spaces possible.

The environmental approach to information, deduced from Maturana's ideas, suggests that future research should contribute to the creation of a wider transposition of his concepts into all the different situations that are relevant to the understanding of information and space, such as, for instance, studies of place qualities. Future research could also improve on this approach by taking the concept of '*disturbances*' as a phenomenon that includes a pattern called '*information*' and extending the theory to other concerns, both in architecture and other fields. The main point would be the achievement, in fields such as architecture and computing science, of an understanding of a concrete communication process within the environment, similar to those, for instance, that have already been proven to exist by some studies in biology. From a biological standpoint, cells and other organisms can use their physical substratum to chemically or electrically trigger mutual disturbances, which are regarded as part of a communication process (Perbal 2003). On a micro-environmental level, taking into account only the cell and its structure, for example, so-called '*cell signalling*' is part of a complex system of communication that governs basic cellular activities and coordinates cell actions (Friedman 2004). The ability of cells to perceive and correctly respond to their micro-environment is the very basis of development, tissue repair, and immunity, as well as normal tissue homeostasis.

This latter suggestion for future research has the advantage of not being limited by the constraints that are normally imposed on studies based on paradigms, such as those already used in rationalistic models or theories, for example, Shannon's '*Mathematical Theory of communication*' (Shannon and Weaver 1949) or other abstracts models from social studies. Also the behaviourist approaches to information, such as those in psychology or, such as Gibson's '*The Ecological Approach to Visual Perception*' (Gibson 1986) and Rapoport's '*The Meaning of the Built Environment: a Nonverbal Communication Approach*' (Rapoport 1982) will be enriched by Maturana's understanding of cognition (Maturana 1980). It has already been mentioned that the rationalistic and empiricist paradigms, grouped together under the name the '*rationalistic tradition*' in Chapter 1 (see section 1.8 on page 26) only manage to provide narrow models to explain the complexity of communication in the context of the human domain. Maturana's approach, however, manages to avoid the separation of that observed context by the use of his method, which includes also an account of the distortions caused by the observer's angle of vision on the phenomenon concerned.

About cheapening solutions with IT usage in projects to public spaces, that there are economic advantages can be intuitively deduced by the observation that the projects reduced the need for expensive physical interventions in the place concerned by means of the increased use of wireless solutions. However, this merely suggests a starting point for further investigations aimed at making detailed comparisons and finding out definitively whether solutions provided with IT are really more economic than those without it.

Bearing in mind the contemporary pace of the evolution of Information Technology and gadgets of digital technology, further exemplifications of products and devices could be added to the table which correlates the qualities of place and IT components in future research to allow extended interpretations of their potential contributions to the informational and spatial structures of the place concerned. This process of refining the table by analysing IT components in terms of their relevance to interiority, visibility and appropriation should be continuously revised, particularly with respect to information about the available technology at a certain point in time. The fact is that with the introduction of that table – or interpretation based upon that table - the framework established conditions for the ongoing study of new IT components, interpreting them according to

their potential contributions to the qualification of space in terms of interiority, visibility and appropriation, thus making it possible to classify their potential use and reinvigorate the qualities of territoriality, privacy, identity and ambience. The continuous process of study aforementioned implies future research aimed at keeping the list of IT components mentioned in that table up to date.

A last suggestion for the broad field of future research projects, regarding the quality of the projects developed with digital technologies emerges from the consideration that the use of IT should help dwelling. This stresses that all the technological '*gear*' deemed to be required in architectural spaces should only be stressed in terms of the role they play as a kind of equipment that is part of the dwelling, after careful study of the contributions they may make to the improved qualification of the built environment.