Digital Territories and the Design Construction Continuum

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The purpose of the paper is to bring together the two newly elaborated concepts of Digital Territories (DT) and Design Construction Continuum (DCC) in order to approach the design of evolving – intelligent environments.
Digital Territories is a concept elaborated 2005 by a Core Expert Group, conceived as an ephemeral Ambient Intelligence (AmI) space. DTs formed through the interconnection of physical objects embedding digital technologies, postulate the integration of the physical and the digital world, searching for operative definitions of new evolving in time functionalities. In DT's, bridges between the physical and the digital are discrete elements disposing of certain autonomy in their conception and internal structure. Bridges have to be designed and located.
The DCC proposes to relate design, fabrication and construction through information networks (it is in fact a DT). Through the DCC approach, design information is becoming construction information and industrial fabrication information. The DCC has to integrate interaction design and respond to questions posed by DTs design.
DTs are integrated to DCC by constituting an intermediate level between building programming and design. Intelligent Building Components, that is AmI components operating as bridges between the physical and the digital in Digital Territories formations, cooperating to develop swarm intelligence applications to architectural space, are elements managed by the DCC. DT's are about spaces communicating and the DCC is about communicating (design) space.

Keywords: *Digital Territories; Design Construction Continuum; Interaction Design; Evolving Environments; Intelligent Environments; Location Diagrams; Building Programming.*

Introduction

The purpose of the paper is to bring together the newly elaborated concept of *Digital Territories* (DT) and the *Design Construction Continuum* (DCC) approach in order to seek the design of evolving – intelligent environments.

Digital Territories is a concept elaborated in 2005 by a Core Expert Group with the assistance of outside experts, for the European Commission Directorate-General Research, under the supervision and funding of JRC/IPTS (ATLANTIS, 2006). A DT is conceived as an ephemeral Ambient Intelligence (AmI) space. It is cre-

ated for a specific purpose and integrates the will of the owner (an individual or group operator) with the means to achieve it (including infrastructure, properties, services and objects) within an AmI space.

The Design Construction Continuum (DCC) proposes to relate design, fabrication and construction through information networks (it is in fact a DT).

DT's are about spaces communicating and the DCC is about communicating (design) space. DT's are about interaction design, that is the design of intelligent evolving environments which is totally different from design interaction, DCC focuses, for the moment, in the building design process, from programming to realization, leaving open questions on the integration of AmI spaces' design in the early build space design process.

From a research orientation and development point of view, DTs are mainly based on information technology research and are interested at space design as a secondary issue, when dealing with location of information processing and management activities. On the other hand, DCC is targeted to the building realization, proposing a new paradigm of construction rationalization, based on information technologies, shifting from the machine paradigm, but staying very close to the axis that brings us from industrialization to mass customization, that is a technical scope ending with realization, integrating future space evolutions as a research future development to come.

The proposed hypothesis is that in order to seek the DCC as a DCUc (Design Construction *Use* Continuum) we might integrate the design of DTs in the DCC, or at least find the intersection points of DTs design and DCC. For this purpose we firstly outline the main characteristics of Digital Territories giving emphasis on space aspects present in the Ambient Intelligence (AmI) approach. Then we will refer to characteristics of DCC that could benefit from an DT integration. Finally we will define modes of DT's presence in the DCC. In other words, DT could be a useful concept for thinking the design and realization of Intelligent Environments.

Digital Territories

A territory is primarily defined in *geography* as an arrangement ("agencement") of material and symbolic resources, capable of structuring the conditions of existence of an individual or social group and giving them in return one definition of their own identity (Levy and Lussault , 2003). There is no territory that is not linked to a *representation* model and therefore to an identity, a *collective mental construction* making the world intelligible. Territories are linked to the notion of *appropriation* leading to the question of *control* and *boundaries*. Territories are always related to *territorial models:* There is no territory without a territorial model, organizing and disposing social realities in defined places. The relation of the concept of territory to that of space is ambivalent, in the sense that space is abstract and territories always support concrete activities. Territories, in geography, are also related to networks, in the sense that networks could define territories: There are activity networks, social networks, telecom networks.

The term Digital Territory was elaborated using "territory" as a metaphor in Ambient Intelligence (AmI) space. "AmI space consists of a set of technologies, infrastructures, applications and services operating seamlessly across physical environments (e.g. neighbourhood, home, car)".

A DT can be composed of sub-spaces, which are determined with respect to their services and usage. The sub spaces are not expected to have a proximity relation. DTs formed through the interconnection of physical objects embedding digital technologies, postulate the integration of the physical and the digital world, searching for operative definitions of new evolving in time functionalities.

"A DT is defined not by physical space or borders *alone* but by the following non-physical characteristics as well:

a. information processing and/or information exchange with the external to the DT world,
b. reaction to events taking place externally to the DT,
c. its owner/governor, who uniquely characterizes this DT.

However, since information is not a physical entity that can be enclosed within a clearly defined physical space (e.g. disk surface) but it can move and change forms and shapes (carrying the same information content semantically and entropically) it can be thought of as an ubiquitous entity possible shared by many DTs. Thus, an important characteristic of DTs is the ability to share, transform and route information (both about themselves and about other DTs)".

The term Digital Territories is useful for defining (digital) space not as a fluid and an infinitely extensible one, but as disposing an "owner", that is and individual or collective actor disposing an intention related to its constitution, a space delimited also by "borders" dealing with questions of privacy and security, and a specific arrangement of digital and physical means serving its scope.

Among the sub concepts intervening in the definition of the newly elaborated term of Digital Territories, "bridges between the physical and the digital" seems to be of special interest for architectural thinking and practice: Bridges are defined as discrete elements disposing of certain autonomy in their conception and internal structure. Sensors, actuators and RFIDs are examples of bridges between the physical and the digital. Building a bridge is a *design decision*. It shows intention, expected functionality and changes the nearby area of the two banks it links.

Bridges could be *temporal or ephemeral*. A DT could be characterized by its ability to create new bridges, by the ease with which bridges are formed or broken. A DT must be able to accept a new bridge and integrate it to its overall functionality. A DT must be able to continue functioning if one of its bridges is broken.

Bridges have to be *located*. Even when bridges are mobile, they obey to patterns of movement related to models of space in which they circulate. They are related to physical space in various ways. Bridging means that you create the conditions that allow communication and exchange of data to happen. It implies the answering to the following three questions:

- Where bridges are located and how (location model)
- What type of context information is processed (context model)
- What functional – (network model) links them

From the above three questions the one referring to the location model definition seems to be closely related to architectural design. Firstly proposed by Mc Cullough (2004), it could be redefined as location *diagram*, in the sense that not only time must be introduced, but also a *virtualization* process must be present rearranging the bridges' disposition and functionality in space. Changes or evolution of their structure according to new needs, must be previewed.

The location diagram refers to the *distribution* and *integration* of AmI components to space.

Their *distribution* follows a logic and defines the physical extend of digital territories: Managing energy consumption includes distribution of sensors to the building's skin, while organizing a museum's digital territory includes the distribution of AmI components close to the exhibits.

The *integration status* of AmI components informs us whether AmI components are related permanently to one place or mobile, integrated to the building fabric or clipped on. A location diagram defines a complex scheme of integration: In the museum example, AmI components attached to the exhibits, are connected to mobile ones (visitors RFIDs) while others are integrated to the building for variable conditioning of temperature and humidity.

If space design provides the physical conditions for activities to take place, their definition implies the definition of related to them Digital Territories, having as inherent characteristic the distribution and integration of AmI components. Thus DT's design is closely related to the design of physical space at least through the bridge's definition and positioning.

Design Construction Continuum

The *Design Construction Continuum* (DCC), proposed by Kolarevic (2003) relates design, fabrication and construction through information networks (it is in fact a DT). Through the DCC approach, design information is becoming construction information and industrial fabrication information. The tools supporting the DCC approach are a *parametric – generative* logic invested in a *3D model* managed by *databases*.

The 3D-model is less considered as a representation tool and more as a vehicle of information assuring the coherence of the DCC. It is also considered as s field where the management of the relations of all participants in the design – construction process takes place. But the 3d model can play its role of coordination only if it is equipped with the ability of absorbing the pressures and demands of change, due to the active presence of the actors participating to the design – construction process. That is, if it is equipped with a parametric – generative logic.

User activities, expectations and desires inform the design database during the design process. Mass customization is thus proposed to an architecture that deals with user defined variations, with *locality* restrictions and the expression of the *unique*. The digitally variable takes the place of the standard. The debate for the definition of the identity (of a product) shifts to questions related to what is stable and what is parametrically defined.

At the same time, The DCC has to integrate interaction design and respond to questions posed by DTs design. Till now, the DCC is mostly investing in the rationalization of existing building technologies in a direct line of thought that links machine production to the open industrialization and from that to the building information management of today. An effort to extend the DCC towards the building's lifetime, would propose a larger conceptual field, adding issues of space transformation in time and interaction design.

The questions arising from the proposition to extend the DCC towards interaction design could be of particular interest:

- Interaction design, linked to the design of *dispositifs* prompting but not defining in detail, has to deal with instable space identities
- In the initial design phase we have to represent the "not yet defined in its details"
- We have also to define the constructability of intelligent evolving environments, not as kinetic architecture, nor as "screen – architecture", but as environments that evolve in their characteristics and qualities.

Digital Territories related to the Design Construction Continuum

Digital Territory is a particular conceptual framework for AmI environments. An essential characteristic of the AmI approach that we must take into consideration is that it is developed through integration of components into existing artifacts, giving birth to new functionalities. AmI approach could be seen as a virtualization of the *existing*, parasitic in nature, in the sense that it is integrated to an existing functionality that is transformed through AmI implementation, fed initially by its host and developing in time an interdependency relation (Papalexopoulos, 2003).

A soft / hard division could then appear at a*ll levels of a building fabric*, almost disposing a fractal logic. The building's static structure may have hard (unchanged) and soft (changing) elements, but it also can, as a whole, form the hard structure to host soft elements. At the same time, a painting film could be conceived in its hard (primer) structure *and* its soft (smart pigments) dimension. Furthermore, a "hard" element could be switched to a "soft" one if a specific operation is triggered from a specific agent and this permanently or for limited lapse of time.

We have to distinguish this rationale from the '70s hard / soft building's division that Habraken promoted. In that sense, the hard/soft dichotomy could be replaced by the stable/unstable one, making reference to the degree of reaction to external or internal forces.

The above scope could be served by the definition, design and application of *Intelligent Building Components*, that is AmI components operating as bridges between the physical and the digital in Digital Territories formations, cooperating to develop swarm intelligence applications to architectural space. *Intelligent Building Components* are included in a definition of future research axis, implementing the concept of Digital Territories and extending it towards space design, conducted by Dimitris Papalexopoulos and Achilles Kameas. We could enumerate some of their characteristics:

- They exchange information between them, with the environment and the users.
- They are positioned to strategic places, following a location diagram.
- They have a common structure
- They are grouped to form functional ensembles.
- They are interchangeable.
- They could support damages and mal functioning, since others nearby cover the gap.
- They are not simply (!) distributed ambient computing elements, but they are also operators that change their context, indicate future trends and space transformations to the user, they catalyze new architectural forms and space activities.
- As hyper-catalysts, they are the physical building "blocks" of interaction and interaction design
- As they do not replace existing buildings' elements but are integrated and transform them, and for this their design modules will be integrated to the existing cad logic and transform it.
- Because the design of a building must also be the design of a building database that evolves and follows it through its lifetime managing information about uses, damages, renovations, costs etc. they will be closely attached to it.
- If produced first, constructed first, or will be the first to take a place in the construction site, they could command CNC for the production of other elements that follow the construction (living tags).
- As building components, they can be integrated to renovations and to new buildings, increasing thus their application possibilities.
- They are integrated in a layered way, as the first ones prepare the terrain for the seconds to come. This dimension is very important for the user acceptance of a totally new environment. Their layered introduction has to be designed in a way to accept possibilities that open to the unforeseen.

In that sense there is an *intermediary stage between programming and design*, concerning the definition of Digital Territories related to a specific building or design operation. That means, that the whole building could be a "bridge" in a larger DT formation and, at the same time, parts of the building, groups of subspaces, or even distinct building elements could be "bridges" of different or the same DT.

The above theoretical proposition could be illustrated through a recent architectural project at Xanthi, mentioning only a limited number of elements related to our theoretical purpose, in order to clarify the approach. The architectural project of the Institute of Cultural and Education technologies, was commissioned by the General Secretariat of Research and Technology at 2005. The project team is Eleni Kalafati, architect, Panos Chatzis, civil engineer, INSTA, mechanical engineers, architectural consulting Dimitris Papalexopoulos, civil engineering consulting Manolis Manios. The Institute for Civilization and Education Technology Institute (Athena)[1] is a research center making intensive use of information technologies. The Institute concentrates its scientific activities a) to the application of Information Technology to the study of texts, analyses, study and registry of languages, works of art, monuments. b) to the study of related material, particularly ceramics, paper and parchments and c) to the application of information technology to the area of Education such as Distance Learning and Education-on-Demand.

Its Laboratories were divided in "hard" ones and "soft" ones.

[1] http://www.ipet.gr/ :june 2006

The "hard" (such as archaiometry) are well defined spaces with very clearly established physical and digital boundaries, making use of sensors to control radioactivity. Those laboratories are designed as "closed" DTs

The "soft" ones are oriented towards the development of interactive educational software, with continuous space rearrangements and the possibility of collaboration with external research teams. The possibility to plug-in ephemeral spaces hosting researchers is also faced by the architectural proposition. Those laboratories are envisioned as "open" DTs.

Changes in the "hard" ones are not happening everyday; they are programmed and need major building operations. Changes in the "soft" ones could appear randomly, according to each research project's evolution.

The "hard" ones are of building elements of extreme accuracy that a DCC could provide. The "soft" ones need a design s/w that could respond to not known changes during the building's lifetime.

Naturally, there are soft elements defined inside the hard DT and vice versa.

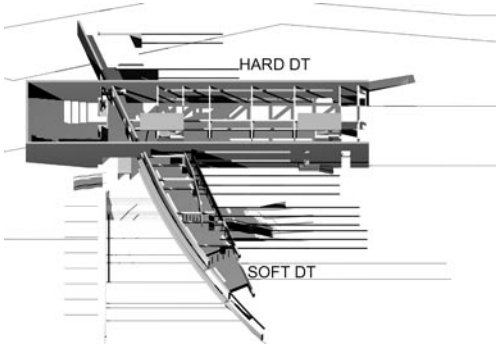

Figure 1.
Initial construction

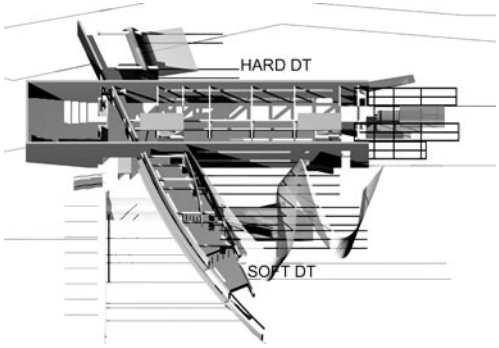

Figure 2.
Future extensions

Conclusion

The DT concept is recently elaborated and is now at an evaluation phase. Actual and future researches will validate it. For space programming, design, construction and use it seems that the DT concept will be valuable at four phases:

- Initially, at the phase of space programming, DTs must be defined in order to handle the complexity of spaces evolving thought AmI components integration.
- During the design phase, DTs must inform the 3d model and the databases managing it, for the existence of location diagrams handling "bridges" location and their integration into the building fabric.
- During the construction phase, DTs are closely related to construction management.
- During the building's lifetime, DTs are fully developed and in action, managing the evolving space functionality, *memorizing* events related to the building fabric, proposing space changes, leading to new space design decisions and therefore to new partial construction activities.

The physical part of DTs that are the "bridges" (between the physical and the digital) are operating during the building's lifetime serving and changing the environment they are part of. They have to be located and integrated, so their design is part of the initial design process. The way they will affect the constructed environment must be taken into account. A DCC approach extended from programming to the building's lifetime could effectively support the active presence of DTs before, during and after design and construction.

DTs are operators changing their context as they evolve themselves. Does taking them into account during the design process catalyses new architectural forms and space activities?

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