The Impact of Digital Architecture Design in the Conception and Management of Dwelling Environments

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Abstract. *When technology moves forward, architecture changes with it: it changes the architecture methodology and it changes the architectural result. This paper discusses the variables involved, pointing the major constraints to the intensive use of ICT in the architectural process. It highlights the need to rethink the user's involvement in the conception of the built environment, increasing it, and suggests new approaches to meet this need by using ICT and VR.*

Keywords. *Smart Houses, Virtual Reality, BIM, Dwelling Environment*

CAD becomes DAD

The relationship between Architecture and the Information Age is bidirectional; whenever technology moves forward, architecture's nature changes with it. Technology alters the way of thinking and practicing architecture; and simultaneously, architecture demands from technology new solutions for conceptualisation, functionality and aesthetics.

The first misconception Portuguese architects had about new technologies was of a sophisticated Rotring, to which contributed significantly the Portuguese translation of CAD: "Design" was translated to draft, excluding the idea of managing simultaneous activities, like the understanding of the problem, the formulation and validation of different possible solutions, and a positive approach which would bring to the surface promising opportunities. The inclusion of this subject into the academic environment (lecture and research) stimulated the evolution on the way to BIM concept and Digital Design (Pentillä, 2003).

New technologies are changing the conception and construction process and demand a revaluation of theories and methodologies (Oxman, 2006). Regardless of all the integration functionalities as to tailor the standard templates to meet the author's specific needs in a given project, thus dramatically reducing time waste, this seldom happens: standard templates and objects are the most commonly used. The main reason that explains this is that 3D Modelling serves mainly for marketing purpose, forgetting the need for the integration of elements and specialities, the requirements of functions or the inhabitants' features.

There are plenty software packages to promote the use of new technologies within the conception, representation and communication of the built environment: some are more user-friendly others require more complex knowledge. Although the final result is directly dependent on the architect's imagination, it is also truth that the conception of more fluid forms is closely related to the use of different software solutions, some of which primarily conceived to support other disciplines and professions. These packages, (such as the ones designed for emerging fractal geometry, revealing the contribution of mathematical expressions on them), allow an experimental approach, enabling fluid and organic forms and spaces, associating its use with CAE and animation applications (Kolarevic, 2003).

Buildings can be designed, informed, fabricated and assembled with the support of digital means (Oxman, 2006). Unfortunately, only a few firms, with renowned architects, mainly devoted public buildings design and conception, are using ICT, explicitly DAD solutions; their work challenges the architectural process as well as the impact of the building within urban environment (a good example is the Guggenheim museum, by Frank Gehry, in Bilbao).

While the quest for iconic buildings continues, there is an emerging and increasing awareness that architectural pieces are meant to be used by human beings. The contemporaneous inhabitants are more demanding. Comfort, work, leisure and communication facilities are some of the main concerns. Again, digital technologies are crucial in the way that interior environments can promote the sense of security, comfort and communication with the outside world. This idea should be seriously considered while designing the built environment on the way to its humanisation and sustainability.

Be anywhere from there

"Physical architecture is designed and built to create meaningful places in which society can inhabit and interact." (Campbell, 1996)

New technologies influence or determine the conception of new forms of buildings, as well as promote an informed urban tissue. Nonetheless new technologies can also be embedded within the building performance allowing different ways of inhabitation.

No matter how iconic a building can be, it still needs to support the user's basic needs. Contemporary users, although very different in habits, and methods of doing (work, study, shop, communicate, etc) have basic requirements that must be supported by the dwelling environment. The building and the neighbourhood will be characterised by multifunctional dwellings (and neighbourhoods), where the traditional daily cycle will be replaced by the possibility of twenty-four hour connections (Mitchell, 2000).

Dwelling environment became one of the most interesting issues to explore, as almost anything can be performed from there (through technology). Furthermore, different ways of living and different population (like the expanding elderly population), require more support and flexibility from their habitat. Physical constructions are able to include sensorial systems to control temperature, moisture, light, movement tracking, but communication between them is as crucial as the communication with exterior centres. The result should be a more secure environment and the sense of companionship and support for (in)dependent individuals (Mitchell, 2000).

Churchill once said:"We shape our buildings, and afterwards our buildings shape us"; this interaction between building and user is

truer than ever before. The use of technologies in our activities emerges the need of new typological configuration, new construction processes, finishing materials, equipments and consistent pos-occupation evaluation. Dwelling configuration is no longer limited to family or personal functions but also work and social features (Caramelo Gomes, 2004.)This postulate is as true as dynamic; in the last decade, there has been a global acceptation as a rapid development of new technologies, as well as their rearrangement beyond public and work environments to individual and dwelling ones. This dynamic process invites an upgrade of Churchill's idea with the statement of Stewart Brand "First we shape our buildings, then they shape us, then we shape them again-ad infinitum" (Brand, 1995)

Regardless of the technology available, human beings need the feeling of belonging to and the sense of shelter from the outside world. Dwelling environment will be assessed and judged by its response to human requirements, activities and social contacts as never before. However, the sense of "there's no place like home" will continue and emerges stronger than ever; residence can be home or the world either because of individual needs or just by self imposition.

A rapid search in the internet shows different approaches to the "house of the future" concept, while evidencing its common issue: technology. Some are just prototypes; others are just conceptual representations; others are constructed to permit visiting (Figs. 1 and 2); in common they have the fact that they do not support the experiment of someone or a family living there for a couple of weeks. The deficient human participation disqualifies the validation of the model. This is the result of the financial requisites and logistical structure needed to promote this type of experiment.

Fig 1 – House of the Future, Lisbon - Portugal

Fig 2 – House of the Future, Lisbon - Portugal

In fact, these examples appear as technological show-rooms, to show the capacity of technology embedded on them or to justify some research programs. The information available does not reveal human interaction, experimentation and impact within human physical, sensorial and social behaviour. The embedding of technology within our buildings, regardless any awareness of its impact on human behaviour, will probably induce a deficient and out of context exploitation of it.

This reality, (illustrated by different examples within public buildings and luxury residence neighbourhoods), can lead to strongly boost the overheads of the building without any benefit to its performance or to improve the quality of life of its users. Human spacial behaviour indicates the relationship between individuals and built environment; well planned space will promote a good spacial behaviour; despite this information, these experiences demonstrate that simulated environments are more focussed on environment's physical qualities like light, energy and thermal comfort than in evaluating spacial impact to human behaviour. (Kalay, 2006)

The analysis of place's spacial qualities can help different professionals to rethink spacial configuration and the relationship between elements that compose a typology (Key et al., 2008). Different authors, as anyone of us - as users -, understand how a built environment can influence human behaviour in its physiologic, functional, perceptive and symbolic understanding. The acceptance of this postulate raises the importance to embrace it on the designing of any space; nevertheless, the need to envisage the different ways to assemble this information emerges.

Virtual Reality' contribution to the built and human environment

"It may be so, there is no arguing against facts and experiments", (Newton, 1855)

Virtual simulation of the built environment can be very helpful to the analysis of its influences in determining human behaviour (considering physiologic, sensorial, and functional performances), from this analysis different conclusions can be reached and some can be included on the traditional or standardised construction to achieve a more responsive and humanised built environment.

Forms and spaces are always a matter of discussion, opinion, but theory and practice show that they are always related to economical pressure, financial budget, property's owner objectives and technical opinion or experience. Users are not really involved in this process, though the end result is to be acquired and used by him/her.

Virtual Reality has the ability to perform virtual modelling which can simulate reality. These models can do more than planning or forecasting technical issues once they have the chance to create virtual sensations and thus real reactions and emotions. The importance of virtual environments relies on the hypothesis that the individual has the illusion of being involved by spacial information, perceiving the ambient as reality, feeling the need to interact with the virtual scenario. The sense of reality is easy to perceive once the required skills to participate are very similar to the ones required on the real environment.

Nevertheless, such technology is primarily used to analyse physical qualities of the built environment and to marketing products from different areas: such as promote tourism and cultural access through web pages with links to virtual visits or to promote luxurious neighbourhoods.

Following these assumptions, reference must be made to the project developed by Yan and Kalay (2006), which aims to analyse the human spacial behaviour based on the creation of a virtual user, characterised to interact with a virtual space. The

user characterised by a detailed study of the different individuals which use the real space (which inspires the experience), resulting in a performance of the goals, social character, perception and physical behaviours and interaction with built environment, in a similar way (or just an imitation) to real life.

These virtual models can be very helpful to this kind of studies and have the ability to be updated to new experiences and objectives, regardless the need of technology and expertise to accomplish such significant details in a given period of time.

Along this study the authors concluded that the evaluation of human behaviour is crucial for the conception process of every space and the desire is to include this information within every designer and architect daily practice, towards a more attentive observation of user's requirements to a more responsive and innovative built environment. While urban environment can be more attractive or complex to deserve the preference from researchers, dwelling environment shows its relevance in the new models of (tele)living and the importance given by individuals in general and those with special requirements in particular.

Other experiments could be developed in academic environment, ateliers and all the professionals related to this area of knowledge. A basic experiment is to model an environment and then perform several walkthroughs, representing different heights of observation, revealing the different insights performed by children, adults, seniors, wheelchairs. This can be interpreted by the designer or can be mediated by individuals that correspond to the walkthroughs features, to a better and comprehensive interpretation of the results.

In a more complex experiment, virtual scenarios will be modelled and trough technology, perceived as real ones; a sample of population chosen randomly will guaranty the independence of the results. The experiment consists in the interaction of these users with the virtual environment to analyse their real attitudes, reactions and emotions. This information will be gathered by the designer, grounding his/her decision concerning the (re)organisation and characterisation of a scenario. Final results will help on further decisions with the benefit of doing it before its construction. This will be very helpful for every building despite form, function or target users, as it can improve all the experiment made within the area of inclusive design. The ethical contribute of the experiment will be to bring awareness to the designer about the need to understand future users instead of creating enclosed by his/her aptitudes, in an aesthetic yet egoistic supported solution.

Conclusions and further work

A deeper insight on built environment illustrates that the final result relies on architect's imagination. However, it is evident that technologies influences significantly the way we conceive, construct and use the built environment. Whilst the big discussion endorses theoretical issues, emerges the requirement of a consistent connection between formal concerns along with functional and users constraints.

Experimental and theoretical research is needed to a better understanding and appliance of CAD and DAD technologies into the creation as well as renovation of urban and dwelling environments.

Pilot studies can be an important as a real scale model to embed new technologies and evaluate their impact into human's daily activities. Matching with this trial, experimental simulation approaches are needed.

Virtual reality appears as a privileged mean to launch the interaction between virtual scenarios and virtual or real users. The information collected is as reliable as the detail of the scenario and the characteristics of the population sample. Theses experimental simulations should be applied to new constructions as well as in the physical and functional upgrade of ancient ones.

A non-immersive environment can produce basic experiments like the conception of walkthroughs, parameterised by the insight height simulating the walk of a child, adult, senior or wheelchair.

Immersive environments can highlight the modelled object in its space organisation along with contrasts of volume and void, light and shadow and finishing appearance. A random sample of individuals will mediate the experiment by their interaction with it.

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