Designing Interactions

A step forward from time based media and synthetic space design in architectural education

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Abstract. *The paper follows the development of digital tools for architects and briefly discusses their utility within education and practice. The move from static CAD tools to time based media followed by programmatic processes and virtual environment design is addressing the evolution of the profession and to an extent reflects practitioners' needs.*
The paper focuses on the notion of interactivity and how it is been addressed in various fields. Borrowing from computer science and game design the author presents a course dealing with designing interactivity, responsiveness and users feeding their input back in the design. The aim of the paper is to analyse and support a new set of tools in architectural curricula that will implement interactivity and integrate it into spatial design leading to a holistic approach promoting intelligence, hybridity and responsiveness of the built environment. Following, the elaboration of the rationale, a brief discussion on tools and project directions is carried out.
Keywords. *Interaction; Virtual Environments; Time Based Media; Curriculum; Intelligent Environments*

Background

During the last decades we have experienced, admittedly in various ways and forms, the infiltration of digital technologies in the field of architecture and (often with an hysteresis) in architectural education. The process has not being smooth, the conceptual framework is often limited or missing altogether, the tools are typically unsuitable, technophobia is high among both the students and teachers and the struggle versus outcome curve rather steep to, at times even, justify the effort.

The field of architecture, counting for a relatively small share in the software market, used to be offered generic *computer aided* (often even called *architectural*) *design (CAD) tools* featuring customisations the software engineers believed to be helpful, important or even crucial for practitioners. The only tool known to the author that has been designed from ground up by architects is AutodesSys FormZ. Hence 30 years on, we still face great difficulties in selecting digital tools suitable for the job at hand and we're typically set back by the tools rather than our imagination/ideas/constructional methods employed and/or budget (Yessios, 2006). Admittedly the typology, abilities and range of tools available to architects has improved over the last decade, *Building Information Management (BIM)* being in the author's opinion the crucial milestone, although still the vast majority of practices use generic tools (like Autodesk's AutoCAD) for all digital drafting work without envisioning the way digital media could enhance the design/production cycle. The above maybe true to a great extent (and especially in Greece where the author teaches and practices) however CAAD is not the only digital means that has somehow "infected" the design process.

Time Based Media (TBM) is a field that architects often "borrow" from, in order to investigate and express visually their ideas through scenario/timeline, research scope and expressive abilities. The available tools in this field are plentiful and intuitive supporting to great extends parts of the design process. The integration, aims and importance of TBM in architectural education has been extensively discussed, presented and analysed (Charitos et al, 2001). Linear narration is an area that TBM excel, although, in author's experience, non-linear storytelling and the resulting mental shifts are areas that TBM are typically lacking, often confusing and setting back students in making the move towards interactive media.

Apart from the "static" tools, digital media has also energised *interactivity* a notion distanced from architectural design often linked to human computer interaction, game design, education, training and various forms of communication. Combined with synthetic space design, as in virtual environments, this topic is taught by the author at undergraduate level at the Department of Architecture, UoTH since 2001 (Bourdakis and Charitos 2002). Course aim is to understand the rules of digital design distanced from any real space scenario brief, enhance problem solving skills, comprehend and design for interactivity as defined and applied in Virtual Reality settings. Sensors, actuators, programming scenarios (Fox and Kemp, 2009) are the issues dealt within the process.

The form/design creation tools are typically rigid, inflexible and incapable of administering change and alterations due to various external factors. Programmatic design processes leading to algorithmic architecture (Terzidis, 2006) or as often called *parametric design* is another field picking up momentum in architectural education over the last decade. Programmatic form development is a complex theme and if dealt in a methodical manner it demands analytic thought, great master of Euclidean geometry and programming skills. Ready-made (scripts-programs) often seen in graduate courses are not facilitating understanding or innovative use of the tools and should be avoided, hence students at undergraduate level should be at least formally introduced to the above mentioned fields.

The logical step forward from parametrics/scripting/programming is *digital fabrication* another research and production direction slowly incorporated in academic curricula worldwide. Form generation and complex spatial assemblies demand suitable (highly specialised) construction workers as well as building sites capable of supporting such designs. The process is typically linked to custom prefabrication, steel or timber structural frames, etc. Laser cutters, 3D printers, 3plus axis CNC machines are among the tools used in education to train and help students grasp the techniques and understand the specificities of designing for digital fabrication. However, all this knowledge is often fragmented and generally unrelated to digital design methods that should precede and setup a tight, overall framework [1].

As far as Greek departments of architecture are concerned, digital media are only partially and at varying levels integrated in the curricula. Main reasons are the highly segmented methods of teaching, lack of widespread acceptance from members of staff (and sometimes even students), running costs (especially true for rapid prototyping systems, less of an issue for laser cutters) and finally difficulties, and even refusal, to integrate them in the design studio. It is only over the last 3-5years that we're seen interesting examples formed and applied in various schools in the country. The department of Architecture at the UoTH was the first to introduce digital media in the curriculum in Greece as part of the original concept back in 1998 and we are slowly trying to integrate digital fabrication and parametric design in the design studio. This paper is an attempt at introducing the last in a series of courses dealing with digital media within the undergraduate curriculum of the department.

Current research & practice interests

The evolution of *ubiquitous computing* that we experience in all forms of human activity (Greenfield, 2006) is also addressing the field of architecture (Bullivant, 2006). The responsive building not necessarily in the closest sense of the term (as discussed by Sterk, 2005) nor in the environmentally oriented approach but on a higher level is a concept generally lacking from academic discourse. There is also an increasing interest in the design and implementation of interactive exhibitions, public art installations (Bullivant, 2007), employing such technologies, utilising mobile devices, locative media, sensing and reacting systems, augmented reality, etc. The above support the need for a holistic/inclusive approach strongly featuring interactivity as a core design component, making it the focus of this paper.

Summarising, digital media have been used over the last few decades to address the topics and/or fields of:

- Architectural design
- Physical design
- Narratives using text or TMB (Coyne, 1999)
- Representations using TMB
- Virtual Environments/synthetic space
- Programmatic design

What is indeed missing from the above mentioned tools, methodologies and approaches is a thorough integration of the concept of change together with interactivity in a systematic manner. Design issues on the environmental performance of buildings, design and implementation of smart homes/environments, information visualisation, implementing dynamic spatial structures representing non-spatial flow/occupancy/interaction datasets are among the topics suited to this systematic approach. The author has been involved in a series of such projects ranging from interactive art installations to smart buildings and has gained experience on real-time systems, interactions, scenario building, coding/programming, implementing and above all human computer interaction (HCI).

Therefore in an attempt to accomplish the knowledge student architects have to master, and borrowing from computer science and game design, the author designed the course "Designing Interactions". In this course, designing interactivity, responsiveness and users' feedback are the core components. Hence the aim of the paper is to analyse and support a new set of tools in architectural curricula that will implement interactivity and integrate it into spatial design leading to a holistic approach promoting intelligence, hybridity and responsiveness of the built environment. Following, the elaboration of the rationale, a brief discussion on tools and project directions is carried out.

Analysing Interactions

A survey, carried out by the author on art and engineering departments, exploring interactivity in design related work pinpointed disparate attempts by few units in departments scattered around the globe. It is clear that the area is not formally researched in depth as far as architecture and architectural education in particular is concerned. There are indeed researchers addressing the technical (hardware and computing) perspective that have been working on the field of Intelligent Environments since the 80ies. Their work is crucial but complimentary to a social science approach architects should be taking towards interactions and the built environment.

Hence a methodological framework formulated by the author, aims at addressing the following topics:

- Visual narratives
- Gaming as a framework for the development of design rules
- Information management and visualisation
- HCI: namely interaction and interface design
- Dynamic systems as far as design and visualisation is concerned

In the following, the application field for such projects, tools and project directions will be discussed.

Target areas

Application areas for such projects can be broadly analysed into digital, hybrid and physical:

- **Digital** are predominantly computer based environments and include the design and implementation of computer games, as well as websites and interactive online content. Structuring the designed environment and organising subassemblies involves complex analyses leading to elaborate database development in order to store/retrieve the necessary datasets indeed a core component of all interactive systems.
- **Hybrid** involves but not necessarily implies the use and interfacing of physical entities to a computing system. Datasets structured in databases are also featuring strongly in this category (Interactive video and cinema). Information visualisation is a key area of research with real data being mapped in synthetic space in order to enable better structuring/relating and ultimately understanding of the gathered data. The delicate cross between real and virtual energises the discourse on new metaphors in data visualisation, building upon existing theories.
- **Physical** denote real life spaces such as art installations, soundscape designs, smart buildings, datascapes, environmental performance analyses, social data constructs, etc. Real life interactions are fed into systems capable of altering environmental behaviours and responses. Sensors and actuators are utilised in programming the (re)actions of the designed space. Furthermore, real time systems typically create massive datasets throughout the life of the system. Analysing the collected data enables alternative methods in visualising interactions, activities and, in general, comprehending the real life of such systems.

Tools employed

In order to accomplish the abovementioned tasks, students need to get acquainted and, to an extend master, the relevant digital tools. Tools are organised in three groups relating to modelling, programming and finally coding of interactivity typically addressed in computer games, art based tools and smart environment setups.

Starting with, *modelling* in terms of geometric constructs need to be carefully addressed. Open-source, namely Blender and commercial tools such as 3DSMax and possibly Maya (by Autodesk) as well as, the more affordable and similar in interface and data handling, Rhino (by McNeel & Associates) can be employed. Programmatic/procedural processes can be supported in a very dynamic manner in Blender using python scripting and the logic bricks of the built-in Game Engine. Alternatively, for a static yet more powerful approach, that easily and graphically accesses all geometric components of the model, Grasshopper within Rhino can be employed. There is enough experience already in using both tools although the author ranks Blender higher in compatibility with the perceived and envisioned tasks.

Programming is vital in designing such environments and therefore has to be thoroughly analysed as far as concepts, operation and logic are concerned on a scope wider than the one proposed by Fricker et al (2008). There are no formal programming courses available at the department of Architecture in UoTH and furthermore the widespread "artist" mentality on both students and staff making them reluctant in acknowledging the "need" for maths and computing. The author and other tutors have, in various occasions, introduced students to programming tools. Starting with, the MIT developed visual programming tool Scratch, designed for primary school education, has been the introductory tool; an easy way of explaining, programming logic such as loops, conditions, processes, messages, etc. to newcomers. The visual, direct, interpreted output is an excellent environment for understanding, learning and testing coding. Attempts at introducing Visual Basic, java and other C style programming languages has not been fruitful and only Processing is used in an elective course thus far.

Following the modelling and programming phases, are the actual *interaction tools* to be employed. On the digital realm, Blender has been already used successfully with VRML97 addressing the lower level of involvement, complexity and potential. The underlying logic of these programs is a good introduction to real space sensing and actuator systems. Dedicated VR/interactive software tools (Dassault Systemes Virtools and the now obsolete WorldToolKit/WorldUp by Sense8) are high cost solutions, often unstable, demanding a great master of formal programming languages (typically C/C++) and in the author's opinion totally unsuited to architectural education. Finally, game engine editors have been used by students in the past with varying levels of success due to limitations in their abilities to depict, interact and experience space in a generic way suited to architecture as opposed to first person shooters and role playing games.

The course will not deal with industrial automation systems (PLCs) but will try to address physical computing (O'Sullivan and Igoe, 2004) by integrating knowledge gained from another elective course where Processing is employed. Thus simple systems based on Arduino boards will be employed, utilising the commercial solution by Cycling74 MaxMSP and/or the open source equivalent PureData both used extensively by artists and slowly finding their way in architecture worldwide.

As far as a real full scale intelligent environment application is concerned, students will be introduced to F.YES, a semi-open source / smart home system programmed in TCL/TK used in a series of projects implemented by the author and soon to be installed at the department of Architecture as the system of choice for managing energy consumption, HVAC, lighting, security and occupancy patterns within the building. F.YES is a commercial solution designed and developed exclusively in Greece and marketed in Cyprus, Australia and lately Germany.

Project Brief

The students' projects will range from theoretical analyses down to code writing and implementation. A smart home case study designed (utilising F.YES technology) and built by the author in Volos is going to be the source of data that students can analyse, understand users' behavioural patterns and investigate interaction routines coded in the system. An F.YES installation at the department building will enable students to explore and modify the energy/lighting code and test it in their own "living" space. At a smaller scale, arduino kit will be employed in order to test sensing methodologies and behavioural scenarios.

Finally, the large datasets produced by such systems will be the starting point for a series of explorations in information visualisation aiming at organising spatial constructs in a data oriented perspective, finding ways to relate rooms/building entities to patterns of use, occupancy, environmental data, energy consumption, etc, reinterpreting the representational codes regarding physical space.

Summarising, students will have the opportunity to design:

- Spatial parameters of smart environments
- Interactions at multiple levels: among discreet users, between human and machine and finally between human and designed physical entities.
- Information visualisation spatial constructs

Conclusions

The course's attempt to link, relate and, overall, involve digital design technologies within an architectural design framework is a complex task with various disciplines and discourses involved at different stages of the project. Students have to familiarise themselves with sensing technologies on a virtual as well as physical level and similarly comprehend reaction and response mechanisms to stimuli. Data collected (typically in an time stamped, event log formatted database) documenting interactions and data processing (in terms of filtering events and analysing structured datasets) is vital for a deeper understanding of such systems. Finally, through the discussions and analyses carried out, students become aware of the complexities and openness of a seemingly simple and closed system. The above facilitates designing at a deeper level than the static spatial design achieved in a typical design studio setup.

Future work would include linking the work carried out in this course to energy/environmental, structural methods and materials courses already available at the department as well as generative design work and discourse.

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