The Architectural Cinematographer: Creating Architectural Experiences in 3D Real-time Environments

Carlos Calderon, Karl Nyman and Nicholas Worley

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This paper addresses the problem of creating new navigation paradigms for experiencing architectural designs in 3D real-time environments. The exploration of techniques other than still images or fly-through animations is complex and manifold, and requires the understanding and skills of many disciplines including cinematography, computer programming, architectural design and communication of 3D space.

In this article, we present the Architectural Cinematographer (AC), a first step towards new navigation paradigms for real-time interactive virtual environments that are intended to enhance architectural walkthroughs with interactive camera effects. The AC is a fully developed modification (mod) of the game UnrealTournament2004™ using the Unreal™ game engine and relies on the notions of architectural concepts, cinematographic techniques and game level design to structure the virtual environment (VE) content in a way that facilitates a perception of design qualities in virtual architecture. AC addresses the current lack of either software or a structured approach to facilitate this in real-time architectural visualizations.

1. INTRODUCTION

> "Architects depend on representations for the design, communication and criticism of architecture. By using representations to articulate and communicate architectural actions and thoughts, architects not only give solution to these problems but also create a language without which no architectural work would be conceivable". [1]

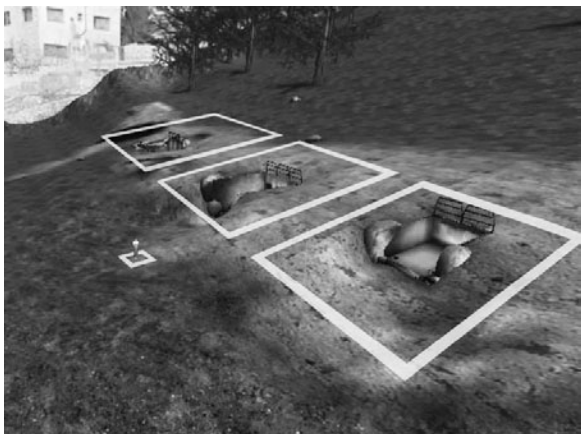
Depictions are so essential to architecture that the type of representational media and technique one uses has a direct effect in architectural making and thinking [2].

However, it is the qualitative differences of one mode of depiction from another that defines the nature and value of that type of representation [3]. Hence, as it has been highlighted by scholars in the field [2, 3], when investigating the role of today's digital environments as architectural representation, the focus should be on how these technologies convey significant aspects of architectural work in new and more advanced ways than traditional representations.

Previous research on digital representations reveals that computers offer at least two unrivalled representational benefits to architectural work: 1) the instantaneous and flexible articulation of several traditional and non-traditional representations (e.g. orthographics, modelling, animations) [2] and 2) the simulation of the architectural experience by conveying architects' essential spatial ideas through moving images [4, 5, 6, 7]. It is this last property which we are exploring with the Architectural Cinematographer. Simply put, with the Architectural Cinematographer we are aiming at providing architects with a tool which enables them to create more architecturally interesting experiences for the user(s) than a self-guided 3D real-time model of theirs or others buildings for that matter.

It is important to notice that, in our approach, the person navigating the environment does guide (with the means of the gamepad, joystick, keyboard, wheel, etc) the virtual camera which brings the virtual environment and its representations visible to us. The dynamic viewpoint, where the sense of agency - the satisfying power to take meaningful action and see the results of our decision and choices [8] - is "placed at the center of the dynamics of sight" and is an important point of departure when we think of other media (film, television and computer animations). For instance, recent work by Nagakura and Chatzitsakyris [7] focuses on the development of new digital animation tools by proposing an automatic process of camera placement and montage. Their tool automatically place the cameras, creates multiple clips, and automate the montage process by editing and assembling clips into a final sequence. This type of work is known as an *off-line* planning approach. Off-line planning techniques take a pre-existing animation path and calculate the best camera placements and Christianson et al. [9] pioneered the incorporation of cinematographic conventions. In this investigation, by contrast, we are concerned with *on-line* or real-time camera placement as the interactively controlled action proceeds. That is, systems which concentrate on camera placement when interactive tasks are performed (i.e. navigation). This, in turn, poses a series of new challenges.

In general, users often have problems comprehending and navigating 3D virtual spaces and they fail to recognise meaningful aspects of 3D models [10]. Particularly within a 3D real-time virtual environment (3DRTVE), the limitation of having to navigate from "standard" camera modes (first-person point of view; a particular character's point of view or from a free roaming mode) makes the communication of the design's spatial aspects more difficult to comprehend and communicate. For instance, the relationship between the different elements of the design is not always clear as one goes through a 3D real-time walkthrough. A look from a certain angle, like a bird's view, could help to compare distances amongst the elements and thus understand the experience aimed at. Figure 1 illustrates how an establishing shot effect has been used to help the user perceive and understand the spatial relationships between three historical tombs in terms of their scale, the distance between the necropolises and their topographical setting within the site. In other words, the establishing shot clarifies the architectural composition at that point.



◀ Figure 1: The establishing shot effect helps the user to perceive and understand spatial relationships.

Similar types of "communication" problems have been faced by cinematographers for over a century. Over the years, filmmakers have developed a set of rules and conventions that allow actions to be communicated comprehensibly and effectively [11, 12]. This paper therefore addresses the problem of communicating architectural designs in 3D real-time virtual environments (3DRTVE) by proposing a camera mode (the Architectural Cinematographer) which incorporates cinematic principles while preserving user interactivity. Furthermore, in conventional cinematographic or narrative productions the architecture is merely a setting for a plot to unfold. The focus is on the unfolding events, the architecture is a secondary backdrop. In our approach, however, the architecture is the event: the actions of the avatar and the cinematic moves are aimed at "unfolding" the building itself. Adopting and adapting the words that Andrea Kahn used to describe Jacques Tati's playtime movie, our approach aims at enabling the creation of real-time walkthroughs "where architecture material, matters pertaining to architecture as well as to architecture's matter, has a starring role" [13].

► Figure 2: Cinematographers have developed conventions to communicate 3D space. In some cases, like Tati's Playtime movie, architecture has a starring role.

It is important, however, that if the user wishes he should be able to control the camera from a first-person perspective and a free roaming perspective too - thus ridding himself of the cinematic aspect and intended viewpoints of the camera. We have therefore established three modes of camera use which can be freely selected by simply typing a console command at any time during the walkthrough: a) architectural mode; b) first-person point of view and c) free roaming mode in which the user is granted the ability to fly and go through any geometry (no collision detection). It is the architectural mode which is the subject of this paper since the other two are already implemented in the game engine used: Unreal TM[14].

2. ARCHITECTURAL CINEMATOGRAPHER

Classic cinematographic concepts formed the basis for designing Architectural Cinematographer's functions, so that a walkthrough might be designed to resemble the visually narrative structure familiar to movie-goers, said narrative in this context being used to enhance user perceptions of architectural concepts embodied in the virtual environment.

The exploration of ways to enhance or improve the navigability of 3DRTVE from an architectural perspective is still in its infancy but the conceptual foundation of our work draws on the pioneering projects carried out by Nitsche [15] at Cambridge University. Our framework has been posited around three focal points: spatial structuring or conceptualization of the 3D space; 2) (cinematic) mediation layers as devices to deliver spatial content; and 3) mechanisms to control or evoke the narrative as the user interactive perform tasks, navigation in our case.

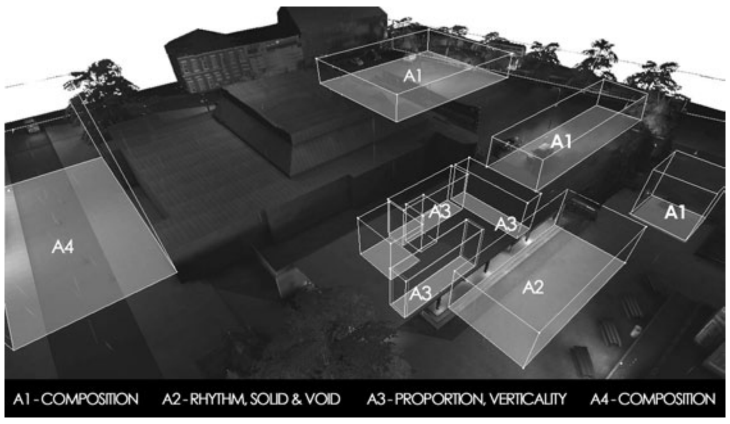
In the following sections, we relate the rationale behind the three focal points underpinning our conceptual framework to the implementation of the Architectural Cinematographer.

2.1. Spatial Structuring

The form of a building is its internal physical structure, as described under some appropriate conceptualization. Many aspects of internal physical structure might be considered and described, but the conceptualization always describes the scope of our interest [16]. For instance, Alexander et al. [17] provide us with a pattern language which is extremely practical in its nature. This can be used for the generation (construction) of architectural elements (i.e. a porch) by combining different patterns. This, in turn, would create a language of, for example, a porch. Whilst Alexander's language is extremely useful to describe buildings from a technological or even functional standpoint, it is not particularly well suited for the conceptualization of buildings from an experiential point of view. Wilenski [18] (insisted that an architect's "business as artist" was with "the definition, organization and completion of his formal experience by creating a concrete object". He went on to propose that "the architect experiences, synthesizes, and creates; he experiences proportion, balance, line, recession and so on, he coordinates and organizes his experience, and he gives it definite form in a building He is concerned from first to last with problems of formal relations". We felt, therefore, that experiential issues are more closely related to aesthetics than to technology and opted for selecting Rasmussen's [19] conceptualization of architecture because, as he put it, "art should not be explained; it must be experienced". Rasmussen's description of architectural concepts is an attempt to, by means of words, help others to experience architecture which is precisely our objective.

From the implementation standpoint, the main challenge resides in mapping an experiential conceptualization of architecture to the primitives available in a 3D editor (the UnrealEd^{TM} in this case) which are based on a Euclidian description of space. This in itself is a very complex problem which can essentially be seen as the encapsulation of an "aesthetic measure" (i.e. architectural concepts) into a computational primitive to be used in a, for instance, 3D editor. This is well outside the scope of this paper.

For the purposes of this our first prototype, we have used spatial volumes: an invisible - not seen when running the environment - data structure available via the UnrealEd as a way to organised objects within the space of 3D world. These spatial volumes are known as Volumes and are part of the standard suite of Actors available to build environment within the Unreal engine. Figure 3 illustrates how our conceptualisation of space based on architectural concepts has been mapped onto a 3DRTVE using Volumes. For instance, let us assume the creator of the architectural experience wants to show the rhythmic quality of a colonnade structure (A2 in Figure 3). He/she then creates a Volume which encapsulates that concept and will be used to activate the corresponding cinematographic technique as explained in the next section of the paper and illustrated in Figure 5. This process can be repeated as many times as the user of the system deems necessary to complete his mapping of architectural concepts onto the geometry of the 3DRTVE.



► Figure 3: Mapping architectural concepts onto a 3DRTVE using Volumes.

2.2. Cinematic mediation

Virtual Environments lack a 'natural' point of view (POV) and the mediation layer which separates the user from a digital 3D space provides a unique opportunity to draw on the rich visual language developed in traditional dynamic media such as cinema to allow the author add "extra" meaning to the virtual space [13, 20, 21]

Matinee

Matinee is the name of the interface within the Unreal Game Engine designed for producing pre-programmed cinematics, short movie-like sequences. Matinee's single biggest drawback for use in modern real-time architectural walkthrough production is that it is not interactive during scene playback; once initiated in a game level (or walkthrough setting), the Matinee scenes progress outside user control (other than to optionally terminate the sequence). In other words, during the pre-programmed run of the Matinee scene(s), the walkthrough participant cannot directly control his or her virtual avatar, called a "Pawn". Architectural Cinematographer, on the other hand, was designed to provide camera viewpoint manipulation flexibility comparable to what Matinee can offer, while preserving user interactivity. Changes of camera position, view angle, field of view (i.e., zooms), scene cropping, filter overlay effects, and more, can be accomplished in a level walkthrough while the Pawn remains under user control, enhancing the real-time qualities that help keep a user involved in the virtual environment (i.e. the sense of agency derived from spatial navigation). AC, therefore, is a more specialized tool than Matinee. Additionally, while

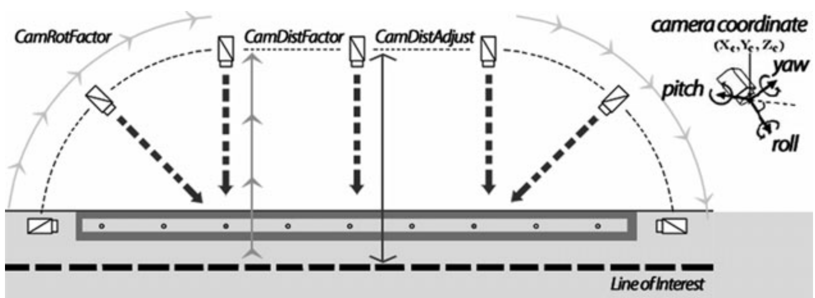
Matinee requires learning and using a specific sub-system interface of the Unreal Level Editor, Architectural Cinematographer's Actors are placed in level just as are those used for other level-building and editing purposes.

Encoding cinematography

From the perspective of designing a new camera mode, there is, however, an important aspect about cinematography which other possible set of conventions lack: the existence of grammars and languages (i.e. [12]) which have been translated into a (film) vocabulary and a series of well known (cinematographic) techniques. Hence, existing collections of cinematographic conventions provide an initial path to map low-level specifications for the camera placements to high-level construction of narratives. However, any attempt to automate cinematography, in our case the creation of a new camera mode, faces a difficulty not faced by real-world filmmaking or storytelling: a description of the rules of cinematography which is explicit enough to be directly encoded as a formal language [10].

In our case, we have solved this problem by creating goal-oriented programmes (AC actors) that enable the recreation of familiar camera manipulations by assigning values to certain variables in the programme. These programmes provide camera movement along all Cartesian world-space axes (see right top corner in Figure 4), plus an Avatar-centred rotational capability. This rotational capability includes manipulations on all Euler angles (see right top corner in Figure 4).

For instance, imagine that we want to recreate a tracking shot: a tracking shot sets the camera along a perpendicular from the line of interest and then moves with the actor maintaining the same orientation (see Figure 4). In our first implementation, the tracking shot module allowed us to modify parameters such as the speed at which the camera moves away from the actor (CamDistAdjust), the maximum distance that the camera can reach (CamDistAdjust), the speed at which the camera rotates to reach its perpendicular vector (CamRotFactor), and the direction of rotation (CamRotFlag) (see Figure 4). A comprehensive description of all cinematic techniques implemented in our system can be found in [22]. A more generic description can be found in Table 1.



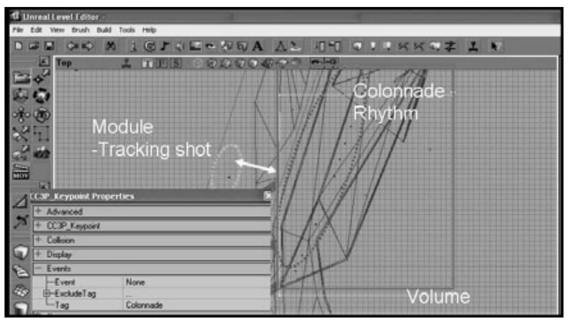
◀ Figure 4: Camera path in a tracking shot; variables (CamRotFactor, CamDistFactor, CamDistAdjust) to recreate a camera shot and camera DOF.

► Table 1. Description of the cinematographic techniques implemented in the Architectural Cinematographer.

Cinematographic Technique	Description
Canted Frame	This actor rotates the view along the viewing axis (roll), providing a canted angle shot
Cutaway shot	Provides a viewpoint from the placed actor's position, looking at the specified look target. The camera is stationary and locked (no mouse control) and Viewer control of the pawn is disabled during the shot; cutaway shots are always timed effects
Zoom FOV	The field of view of the camera is modified
Aspect ratio	aspect ratio for the level
Fader	Enables a transitional fade out to black and back in
Frame cropping	Creates a reduced area of view in the form of a rectangular "window", framed in black. Size and center position of the visible window are specified by the level designer
Tracking shot	Repositions the camera while maintaining the pawn-centered interest, moving with the pawn as the camera changes position
Filter effects	This actor implements HUD overlay effects that act asvisual filters on the scene

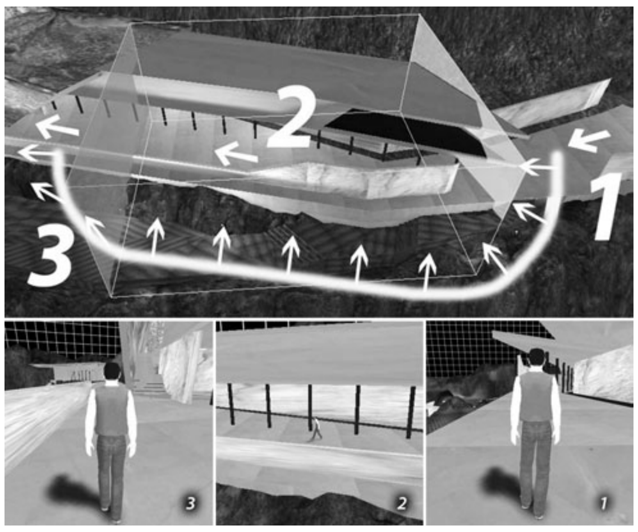
Mediation layer and spatial structuring via an event model

Taking advantage of the tag/event model embedded in the game engine, the AC Actors are associated with specific spatial volumes in the virtual environment, and are activated when the user enters an associated spatial volume. In this context, as explained before, a spatial volume is described by another Actor called a Volume. For instance, let us assume the designer wants to show the rhythmic quality of a colonnade structure using a tracking shot technique. He/she creates a Volume where he/she wants to activate the tracking shot - e.g., inside the colonnade - and links it to the tracking shot Actor via the tag/event model, that is, links the tracking shot Actor's Tag property to the collonade Volume's event-generating script. Figure 5 illustrates this.



► Figure 5: Volumes encapsulating architectural concepts are partnered to AC's actors (i.e. tracking shot) via an event model.

If while navigating the virtual environment the user approaches the colonnade, upon entering its Volume an event is generated in the VE that is recognised by the game engine, which causes the tracking shot Actor to implement the camera move. Figure 6 demonstrates this graphically from the user's standpoint: Window (a) in Figure 6 depicts the user approaching the colonnade from a "standard" third-person point of view; as the user enters the Volume (the wire frame box in Figure 6) an event is generated; the game engine recognizes the event, and activates the tracking shot Actor, which moves the camera into the tracking shot position (the yellow line in Figure 6 indicates the camera path and view direction); window (b) shows what the user sees during the tracking shot while the user remains within the Volume boundaries (see position 2 in Figure 6); finally, the user's action of leaving the volume (see position 3 in Figure 6) generates another event and the tracking shot Actor responds by returning the camera to a third-person point of view (window (c)). More than one custom-coded actors can be associated with a certain Volume, so multiple effects can be triggered simultaneously and will operate concurrently.



◀ Figure 6: User approaches the colonnade, upon entering an event is triggered in the VE which is recognised by the system and the camera module takes over.

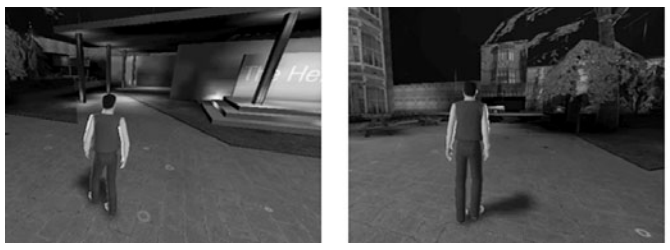
2.3. Controlling a narrative

Within any virtual environment there is always a conflict between the freedom of user movement in order to enable the user's sense of spatial navigation (a form of agency [8]) in the VE, and the need to direct the user to appropriate or desirable locations in the environment in order to further the goals and purposes of the VE. In a VE seeking to portray, highlight and illustrate architectural concepts, it is important that users be guided to the areas where the architectural models can be observed properly and certain details focused upon through the agency of cinematic camera effects. By careful and considered restraint of user mobility, an experiential narrative can be evoked, by which the VE author's targeted architectural principles are communicated to the user more closely to author's original intention. This narrative need not be overt, nor especially linear, but must keep the user's awareness reasonably well-focused on a select architectural component of the VE, rather than some inconsequential aspect of the VE. The narrative model and its use are described in the example section.

With regards to the methods of constraining and directing user movement and attention in a VE, these draw on widely used game designing techniques [23] and can be described by three general concepts: barriers, influences, and enticements. *Barriers* include such obvious elements as walls, fences, cliffs, and dense foliage, but can also be invisible to the user - such unseen barriers are a common game-level technique, often implemented in the Unreal Engine by use of a standard Actor called a BlockingVolume. Though invisible barriers would be considered quite unnatural in the real world, in a VE context they are a commonly accepted phenomenon and rarely break the immersive quality of a VE. Figure 7 shows how fences and foliage can be used as barriers.

► Figure 7: Fences and foliage are used as barriers.

Influences are aspects of a VE that do not directly constrain movement as do barriers, but nonetheless affect how a user moves in the VE. Visible pathways, sidewalks, streets, steps and staircases, usable ladders - all are examples of influences to movement in a VE. They can be ignored, but because users accept a correlation between the VE and reality, user responses to them usually mimic those in the real world. For example, obvious paths influence user traffic in that direction, even though movement is unconstrained. Figures 8 and 9 illustrate how the pathways have been used to influence pedestrian traffic towards the side of the pavilion (Figure 8) and out of the plaza (Figure 9).



► Figures 8 and 9: Pathways have been used to influence pedestrian traffic.

Enticements are VE content specifically designed to attract the user's attention to a certain locale, or conversely make an area less attractive and more likely to be ignored. They can include lighting that contrasts strongly with the general ambience of a VE (extremes of light or darkness, for instance), use of specific color elements in structural or lighting components, graphic elements such as signs, and situational elements that evoke a particular user response (e.g., an unexpectedly open door that piques the user's curiosity) . Enticements need not be overt, and can act in concert to build a form of narrative tension in the user's VE experience. Figure 10 shows how the lighting has been used to entice the user towards an area of interest (the building).

◀ Figure 10: Lighting has been used to entice the user towards the building.

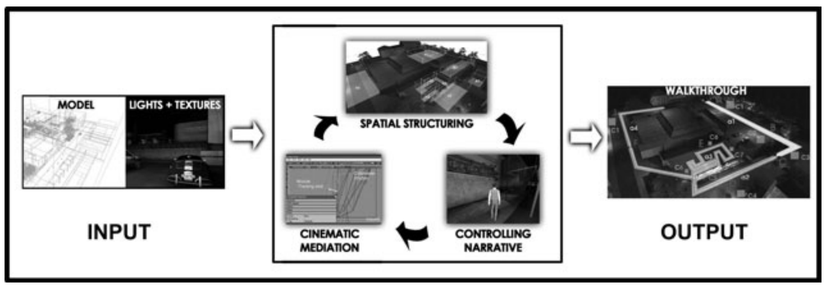
Furthermore, the three outlined concepts can be combined in multiple ways as well as reinforced with the cinematic actors. For instance, Figure 11 shows how filters have been used to direct the user's attention towards a desired target location, the designed building in this case. Similarly, Figure 10 depicts how negative enticements (darkness and rubbish) are combined with barriers (scaffolding) to discourage and, ultimately, prevent the user from pursuing that direction.

◀ Figures 11 and 12: Combining methods to direct the user's movement and attention.

2.4. Workflow

The system's workflow is illustrated in Figure 13. The starting point of the system is a fully developed 3DRTVE, in terms of geometry, textures and lighting, for a specific purpose such as a detailed final presentation and/or massing study. The various components of the 3DRTVE can be developed in third party digital design environments (e.g. CAD packages and image editing tools) but they must be assembled in the UnrealEditor^{TM}. Once this has been accomplished, the creator of the architectural experience identifies and maps the architectural concepts onto the geometry; applies the cinematic mediation layer; and implements mechanisms to restraint the user's spatial navigation. On practice, we have observed that these three steps are sequential but also interchangeable and iterative (see Figure 13).

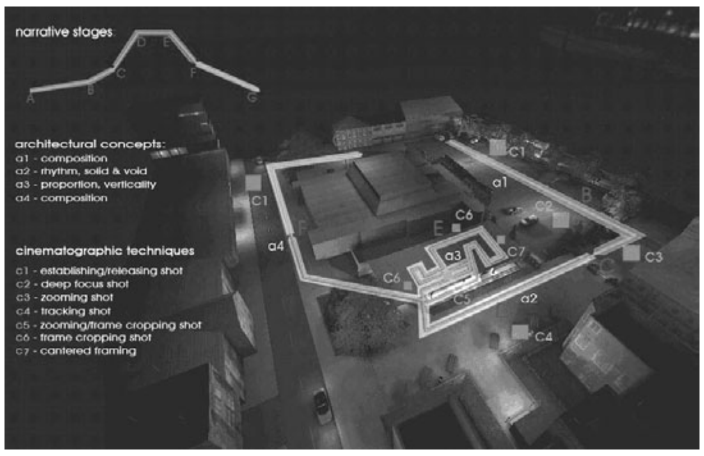
► Figure 13: System's workflow.



3. EXAMPLE

In the example presented in this section, the 3D space has been structured as previously explained and depicted in Figure 5 ; the cinematic mediation layer has been created embedding the AC's actors via the tag/event model available; and the narrative is controlled utilising game level design techniques and follows the established rules and principles of a linear narrative model. The model is characterised for having three well differentiated stages: 1) an introduction with low tension (segment A-B-C in Figure 13); 2) a rise to a climax which usually coincides with the main features of, in our case, the design (segment D-E in Figure 13); and 3) a quickly decline toward the end (F-G in Figure 13). The correspondence between different narrative stages; architectural concepts and cinematographic techniques used is also shown in Figure 14. For instance, in the segment A-B-C - low tension - the emphasis is on architectural composition (a1) and three Volumes are partnered to as many cinematographic techniques (c1, c2,c3) following the mechanisms explained in the previous section. This process is then repeated for the entire walkthrough. Figure 15 shows a series of film strips, following the 1-, 2- and 3-staged model shown in Figure 6 - before entering the Volume, during and after existing the Volume - detailing each architectural concept with its partnered cinematographic technique as it used in the architectural walkthrough.

The rationale behind the partnering is as follows: initially an establishing shot (c1 in A-B-C segment in Figure 13 and a1/c1 in Figure 14) is used to introduce the location of the user and highlight architectural proportion and where the scene is to take place; it also creates a heightened sense of anticipation as to what is to happen next. The user is then shown a cut-away shot of the pavilion (eventual destination) that also incorporates use of a "deep focus" shot (c2 in Figure 13 and a1/c2 in Figure 14) with careful considered use of contrast.. The contrast filter helps to highlight the main element to the viewer yet it also allows the surroundings still to be viewed.



◀ Figure 14: Correspondence between different narrative stages, architectural concepts and cinematographic techniques.

A zooming shot (c3 in Figure 13 and a1/c3 in Figure 14) is established when moving up the stairs towards the pavilion. This shot hides the pavilion initially, helps to peak the viewer's anticipation and to release the viewer as the shot zooms back, creating a heightened appreciation of the pavilion. A parallel tracking shot (c4 in Figure 13 and a2/c4 in Figure 14) is established to create an appreciation of the built form and to highlight the rhythm and verticality (of the columns) and planar nature of the pavilion (projecting, floating roof, and floating walls). This shot also creates a sense of scale and proportion so that the viewer can visualise and appreciate the architecture to a greater level. Once inside the pavilion several cameras are used to create a variety of effects; frame cropping (c5 in Figure 13 and a3/c5 in Figure 14) is used to highlight the verticality of the pavilion, through use of vertical and horizontal cropping; this also allows the designer to anticipate what the viewer would concentrate upon when inside the pavilion. Just before exiting the pavilion, a canted framing shot (c6 in Figure 13 and a3/c6 in Figure 14) is created to again allow a greater appreciation of the verticality and planar nature of the internal spaces. Finally the viewer is presented with a progressive extreme long shot (c1 in F-G segment in

Figure 13 and a4/c1 in Figure 14) that establishes the route taken, acts as a reminder to the location, re-enforces a strong sense of scale and acts as an emotional device to counteract the previous heightened sense of anticipation helping the user descend to a normal level of emotion.

► Figure 15: Architectural concepts with its partnered cinematographic techniques as used in the architectural walkthrough.

4. END USER EVALUATION

Our end users were 13 students with ages ranging between 24-32 who already had a university degree in architecture as well as experience in practice and each one of them tested the AC in purposely created virtual environment of either one of his/her previous design projects or a new project altogether (see Figure 16).

► Figure 16: Screenshots show how Architectural Cinematographer has been used in various projects.

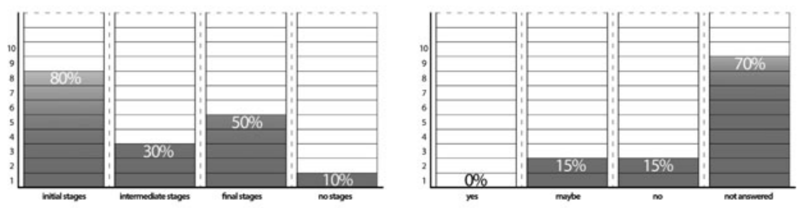
The evaluation strategy was based on similar studies [24] and its focus was on extracting qualitative findings about subjective user experiences rather than defining usability problems of the developed software. In our case the strategy was as follows: first, users were asked to carry out a task using the prototype (in our case was the creation of an architectural walkthrough with a narrative). Secondly, once the task was completed, an open ended questionnaire was used for qualitative analysis.

The *collected data* was a schematic view of the architectural walkthrough similar to the one shown in Figure 14 a video of the walkthrough and a written response to the questionnaire. Based on George and Cowan's methods for formative evaluation [25], the *data analysis* consisted of the following stages: first, identification of any obvious patterns that emerge and unexpected items which do not fit in with these patterns. Secondly, we identified common categories of ideas that emerge from the data (written reports). These categories were derived from our own interpretation of the data. For instance, when answering the question: where in your design process is a tool like the one proposed likely to be used? Answers were then grouped in the following categories: initial, intermediate, final and no stages. Therefore, an answer such as "the Cinematographer could be used at any stage" would count as one for each category. On the other hand, an answer such as "Useful as an initial rough volume modelling tool" would be interpreted as one for the initial stage category. Finally, descriptive statistics such as the frequency of particular comments were part of the data analysis to reflect trends embedded in the data. The graphical or textual representation of this type of indicators was appropriately selected depending on the variables and range of variation of these variables (see results).

Results

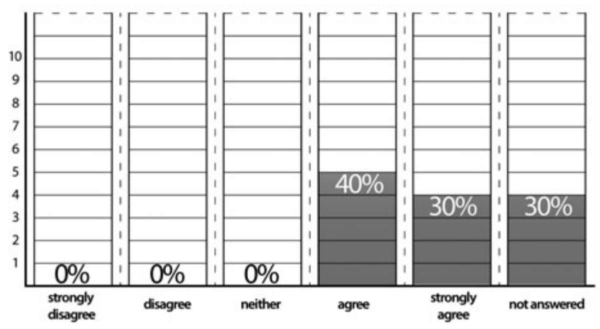
With regards to first question in questionnaire: where in your design process is a tool like the one proposed likely to be used? The identified categories were: initial, intermediate, final and no stages. Our interpretation was that the initial stage represents: concept design/massing studies/site analysis/urban context; the intermediate means: Design development/Material and light investigation/scheme composition; and the final refers to detailed design/presentation. No stages in this case means that the end user did not see any potential in using the Architectural Cinematographer at any stage during his/her design process. More than one answer could be given (e.g initial stages and final stages) and therefore an 80% result for the initial stages means that 80% of our users thought that the AC could used in the initial stages. For the question: could a tool like this influence or change your current design process? The categories were: yes, maybe, no or not answered. Figure 17 shows the results obtained.

► Figure 17: Results to the questions: where in your design process is a tool like the one proposed likely to be used? Could a tool like this influence or change your current design process?



With regards to the appraisal of the theoretical framework, the meaningful categories were: strongly disagree, disagree, neither, agree, and strongly agree and not answered. Figure 18 shows the results.

► Figure 18: Results on the appraisal of the theoretical framework.



Finally, the group session the students were asked individually record three significant things onto a card and then, as a group, they were asked to cluster their answers. The general consensus was that the AC is a good idea/beneficial as a design/presentation tool and the main positive points are summarized in table 2.

► **Table 2. Positive points extracted from the focus group.**

The use of the tool is 'enlightening' - people are introduced to a method of design and presentation that they may not have been before which opens new possibilities for them as designers.
The AC presents an altered perspective to those that people are used to which may infer re-evaluation of designs which may otherwise have been impossible.
To some extent, designs are able to explain themselves without the need for added speech (possibility of AC being used as a remote design tool without the need for the designer to be present)
Architectural concepts could be linked and read as stories as the user navigates the environment. Users could be left to discover the environment and experience the building of a story through the architectural concepts.

The main concerns regarding the use of the AC were more about modelling in a real-time engine than on its use. For instance, the main two issues were: how much work on a model is beneficial? And the level of detail modelled to ensure a best understanding of the designer's intentions? These are topics of research on their right.

5. CONCLUSIONS

The overall conclusion that can be extracted from the results as well as from the impressions obtained from the students is that the Architectural Cinematographer adds value to the design process. We believe that the reason why the approach was so well received is to do with the fact that cinema has deep roots in modern society and people can engage very easily with the screen whereas architectural drawings and 3D models require a little more knowledge and understanding to be able to read them properly. This coupled with the freedom of navigation and interaction which characterise virtual environments makes the approach appealing to designers.

It was unexpected, however, to find out that our end-users believed the AC is more likely to be used in the initial stages of the design (80%) rather than in final stages (50%). Based on the comments collected from the focus group, it seems that massing studies, where scale issues are important, could be an area of application. Regarding the influence of the AC in changing design process, as expected, our initial results seem to suggest that the AC would not change current processes. This was summarised in a student's comment: "Don't feel that it would have a huge impact on my current design process. See it as a very useful aid which could be used alongside conventional methods (model making, drawings...)". The theoretical framework, on the other hand, was well received: everyone either agreed or strongly agreed. Perhaps, the reason of this might be found in another answer: "architectural concepts could be linked and read as stories as the user navigates the environment. Users could be left to discover the environment and experience the building of a story through the architectural concepts".

In this paper, therefore, we have presented a first step towards new ways of navigating 3DRTVE in architectural visualisation. We have also proposed a theoretical framework for the implementation of this type of systems around three focal points and related the theoretical reasoning to our ad hoc software. By doing this, we have outlined and illustrated the problems associated to three important areas for future research: 1) relating an "aesthetic" conceptualisation of 3D space to Euclidian-based editing tools; 2) implementation of spatial cinematic mediation layers which presser user's interactivity; 3) mechanisms to enable a controlled sense of agency derived from spatial navigation. Finally, our qualitative end-user evaluation suggests that these new ways of navigating digital spaces add value to current design processes.

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