

# Educative Visuals – Digital Delivery of Architectural Information for (potential) Heritage Buildings

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## Abstract

*The paper proposes models that address current issues and considerations at several key levels relating to treatment of architectural information, its presentation and delivery methods specific to architecture education requirements. It investigates fundamental digital communication strategies for the understanding of architectural work of heritage or potential heritage values, highlighting how digital simulations in particular could complement other media like texts, drawings and photographs to facilitate an understanding of design. It proposes dynamic visual layering system of information and information types relating to site, construction, materials, textures, design philosophy, etc, while also taking into account feedback from the intended audience.*

*The architectural work featured as an example is of high potential heritage value - an area of special interest in the context of a country with a relatively short architectural history as Australia. The information depicted in the model has a role to supplement a site visit or to communicate independently to the much larger audience who are unable to visit the site.*

*Although the paper does not insist on definite or final prescriptive techniques for the delivery of architectural information of heritage or potential heritage values, it suggests a possibility of standardisation in this area with features and considerations that need to be firstly addressed.*

Categories/Subject Descriptors: E.2 [Data Storage Representations]: Linked Representations; H.5.2 [Information Interfaces and Presentation]: User Interfaces --- User-centred Design; H.5.4 [Hypertext/Hypermedia] Navigation; I.3.6 [Computer Graphics]: Methodologies and Techniques --- Interaction Techniques; I.3.6 [Computer Graphics]: Methodologies and Techniques --- Standard; I.3.7 [Computer Graphics]: Three Dimensional Graphics and Realism --- Animation; I.6.8 [Simulations and Modeling]: Types of Simulations --- Animation; I.6.8 [Simulations and Modeling]: Types of Simulations --- Combined; I.6.8 [Simulations and Modeling]: Types of Simulations --- Visual; J.5 [Computer Applications]: Arts and Humanities --- Architecture; K.3.1 [Computers and Education]: Computer Uses in Education --- Computer-assisted instruction

Additional Keywords: Architectural Information, Media, Architecture Education, Information Representation, Information Visualisation, Computer-assisted Learning, Dynamic Multi-Layered Information

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## 1. Introduction/Background

Information digitisation commands a fast growing interest in the preservation of architectural heritage data. With so much data that have been painstakingly collected, how should they be effectively presented and made available and understood by generations to come? Apart from accessibility and issues concerning message conduits, techniques to achieve coherent deliveries have also become a critically significant issue.

With advances in electronic documentation, graphic presentation and a growing interest in electronic resources, more in-depth information of heritage or potential heritage buildings is likely to be published in digital visual formats and made widely accessible from desktop computers. In order to capitalise on what the present and future technologies offer, there is a need for case studies that explore in-depth types and effective modes of architectural design information representations as an alternative to, and not merely a digital replica of, current print publications.

The main preoccupations of recent research in the digital representation of buildings have been the evaluation and uses of hardware (PDA, Mobile technology, projectors, etc), virtual reality (VR) interactivities, and photo-realistic renderings [AK05, SWL04, NHAH03, YC03, DPF03, WSBW01]. These projects do provide significant factors to consider in the delivery of information content. However, representations and visualisations of architectural heritage work information for those within the academic circle, and especially for the public at large, require attention which cannot be addressed by the improvement of technology alone. Contrary to McLuhan's assertion, [McL64] the medium is not the only message, although it is indeed one of the integral parts of the equation.

Riding on the current available technologies within and outside the field, we approach the investigation to propose some examples of essential delivery techniques. However, it is also realised that in addressing these techniques of delivery, several fundamental concerns specific to architectural information must first be addressed in this paper.

## 2. Information Types

The type of information pertaining to a building inevitably dictates the manner it is/can be effectively presented. For the purpose of this paper, information types are streamlined into two categories:

- *Hard information*, which might be derived from the subject's physical form, environment and condition; this type of information is often collected directly from the site and partly from architectural documentations.
- *Soft information* (the invisible), which may entail functional and effective observations relating to the realisation of design intentions and their impacts, as well as the building's hidden narratives and phenomenology. This type of information may be less tangible and less visual in nature.

The multi-faceted property of an architectural design's hard information is also echoed in the layers of soft information. This includes the analysis of and narratives about the subject, accounts from users, designers and individuals involved, etc. With heritage buildings or archaeological sites where information resources are limited, this aspect often relies on informed guesses.

## 3. Media types

Much has been mentioned on the uneasy relationship between language/texts and architectural descriptions (see examples [Fri00, Fro03, Kou97, KRB05]). Although the outcome of this relationship often renders the subject misunderstood and thus the record of knowledge distorted, these forms of print media are widely accepted due partly to their well-understood limitations, portability and ease of use. Similarly, photographs and drawings have limitations but are still necessary. It is not a question of whether they

should be used but how they are best used in a complementary manner/relationship.

The effectiveness in delivering certain information types is also partly based on the choice between the visual and the non-visual (literary) media types. In visualising the invisible, for example, Bermudez, Smith & Striefel attempted just that – visualising soft information that relate to the human senses. [BSS05] The resulting visual representations were at best interesting abstract visual metaphors, but they would have been reversibly indecipherable as human sensory experiences.

Since most of the hard information could be relayed visually while the soft information still seems to be more effectively explained verbally or textually, the challenge lies in articulating the interrelationships between the non-visual elements and their visual counterparts in order to establish a referencing system that increases comprehensibility.

## 4. Information vehicle

A decision on the information conduit requires the assessment of technological opportunities and limitations. This not only involves the facilitation/technology to present and deliver the types of information but also availability of the technology for the intended audience.

Students and the public at large increasingly turn to the Internet as their first and main source of information (refer to figure 1). The use of the Internet presently requires a compromise between image quality and size. What began as an only text-based vehicle has within two decades expanded to delivering images, sounds, and moving pictures [Lev99]. As technology improves, allowing higher compression qualities and bit-rate transfers, it is expected that the delivery of adequate image quality will become mainstream.

2 In studying this architecture, where have you obtained your information from?		
Resources	Response Percent	Response Total
Books	62.61	139
Journal(s)/Magazine(s)	55.41	123
Lectures	27.93	62
The Internet/Computer	72.52	161
Video documentary(s)	13.51	30
Others	10.81	24
Total Respondents:		222
(skipped this question):		2

**Figure 1:** Excerpt from the results of an international online survey. [KRBR06-a]

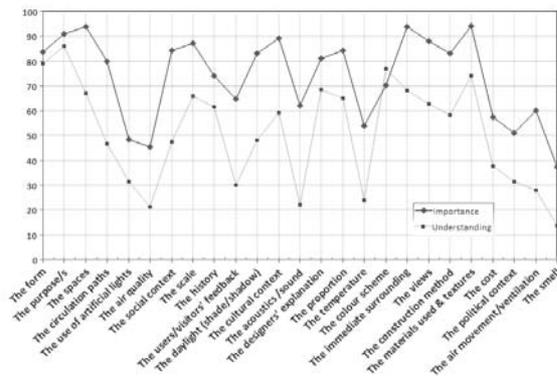
There are also compatibility issues. Operating system variations and the discrepancies found in browsers impact on the display of certain types and format of information. Currently, one of the ways to resolve these incompatibili-

ties is the use of plug-ins, readers or players that work on multiple platforms.

## 5. Information Contents

It could easily be established that architectural information has undergone various manners of representations in publications- such as architectural monographs (of particular architects' works, etc.), most, if not all of which are author-driven in contents and structures. To whatever extent that these long-established publications may have been relied upon as sources of information and knowledge, there appears to be an absence of assessment of the effectiveness they assume to deliver. It is often found that in such publications, readers are met with unrealistic expectations of prior understanding of the subject matters and the publications themselves often seemed author-centred rather than ones that genuinely guide readers to achieve maximum possible comprehension.

A survey has recently been conducted to investigate information contents that some intended audiences value and consider important to them (Figure 2: blue line) and how existing publications have helped them understand a particular building (Figure 2: red line). (For details, refer to [KRBR06-b]) The chart shows that for most content factors, audience understanding level falls almost consistently below the degree of importance they assign to each factor.



**Figure 2:** Audience-surveyed factor importance and understanding scales (based on current publications). [KRBR06-b].

Although some may argue that this general opinion might have been conditioned by the currently available, author-driven resources, it does provide significant insights into audiences' perceptions of important aspects and of their understanding.

## 6. Visualisation Standardisation

The documentation of architecture for construction has a long history of commonly-accepted presentation standards. The fundamental and almost universal requirements that

have continued over time include the use of two dimensional elevations, plans, sections and details to relay crucial information for the building construction. On the other hand, for descriptions and explanations of already built works in which often a visual third dimension is introduced, there have not been such a broadly understood set of standards. There have been common occurrences of photographs, multi-view perspectives/sectional perspectives, isometric/axonometric views, textured/coloured plans, elevations or sections added to texts. But both the extent of media use and the organisation of materials differ from one published work to another.

Architectural digital presentation is currently in a similar but early stage of non-standardisation. Most examples digitally re-adapt the already non-standard traditional printed mode of delivery (see example: <http://www.greatbuildings.com>). Where the product is not intended for in-depth public education or detailed assessment this method is tolerable. For instance, architectural illustrations may be regarded and recognised as a form of art, as illustrated in 'Picturing Architecture' [Lus92]. When this happens, wider open interpretations are not only required but desirable.

However, in cases where architectural design knowledge is to be communicated as a record of and educational resource for heritage work, there is value in establishing a yet-to-be-defined fundamental set of visualisation/delivery techniques. Could there exist the possibility of standardisation or a framework to guide visualisation materials meant for this purpose? For this to happen in the digital platform of this era, some modes of delivery need to be devised and/or extended to allow this accessibility and clarity of information. To illustrate and propose a possible direction, examples involving a case study are outlined below.

## 7. Case Model - Background

One would think that an important aim of preservation of building information of heritage value would be for the benefit and knowledge of the present and future generations. The more pertinent data gathered, the more beneficial the collection would be. It is difficult to fathom, therefore, why preservation works frequently commence only when the information becomes part of the 'Endangered Memory' or is in the brink of the 'Lost Memory' database of an organisation. Early identification and information collection of buildings with heritage potential are essential in order to maintain an acceptable degree of accuracy. It is imperative that documentation commences while untainted and relatively complete information - both hard and soft types - is still available and accessible. This eliminates the need to reconstruct hypothetical scenarios as are often found in cases of heritage or archeological site documentation or reconstruction [HGG01, Saa01].

In our research, the Arthur and Yvonne Boyd Education Centre, West Cambewarra in the state of New South Wales (NSW), Australia, was selected as a model for data

collection and representation mainly for the following reasons:

- It conforms with the local Heritage Council of New South Wales authority's assessment criteria for heritage status [Her01].
- The availability and completeness of information and its absolute significance of the work in the Australian architectural/cultural heritage climate.
- Featured in the Phaidon Atlas of Contemporary Architecture [Pha04], the building is significant to the field as an example of a fine architectural work with sensitivities to the environment.
- It is currently managed by the Bundanon Trust as an education centre for young budding artists to continue the Australian art/cultural lineage. Since it is open to the public, onsite data are readily attainable.
- The availability of people involved to be interviewed. They include the architects, engineers, client representative and builder.
- The relatively remote location of the site necessitates the availability/accessibility of an alternate information source.
- Built on a land donated by the internationally well-known, late Australian painter, Arthur Boyd, it was designed by the only Australian Pritzker-prize winning architect, Glenn Murcutt in association with Wendy Lewin and Reg Lark. The architectural masterpiece, symbolising the efforts by two important figures in the Australian cultural scenes, has won numerous architectural awards, strengthening it as a worthy subject.

## 8. Visualisation Approaches

Due to the scale of a multi-faceted subject, exemplified in The Arthur and Yvonne Boyd Education Centre, architectural information representations are unusual in that they call for both overall and detailed observations to be clearly included and understood. This frequently translates to a time-demanding process of recording and digital modelling of the subject and more importantly, as outlined later in this paper, unique methods of presenting them faithfully.

Apart from still images, digital presentation vehicles currently in place include predefined walkthrough animations and interactive virtual reality models that can be controlled by the viewer. In architecture, these have mainly been used as a part of the design process for a particular building or to market proposed projects. In academic circles, they are extensively used as illustrations to verbal presentations. As stand-alone education materials, however, they are grossly insufficient.

The following sections highlight two examples of delivery techniques that expand upon the current ones by the introduction of a dynamic information layering system, encompassing various information and types as well as

media. Similar concepts could be applied in other visualisation techniques for education purposes.

### 8.1 Dynamic multi layering approach: Walkthrough / Flythrough Environments

Walkthroughs or flythroughs are useful in providing a quick overall general impression of the site through visual continuity. Typically these are high-quality pre-rendered movies, but they can also involve real-time interactive experiences such as a VR environment [ZdMvG01] or the use of game engines. All these established vehicles have been effective in understanding formal, spatial properties and characteristics. How could we push the boundaries to fashion them into a more effective educational resources?

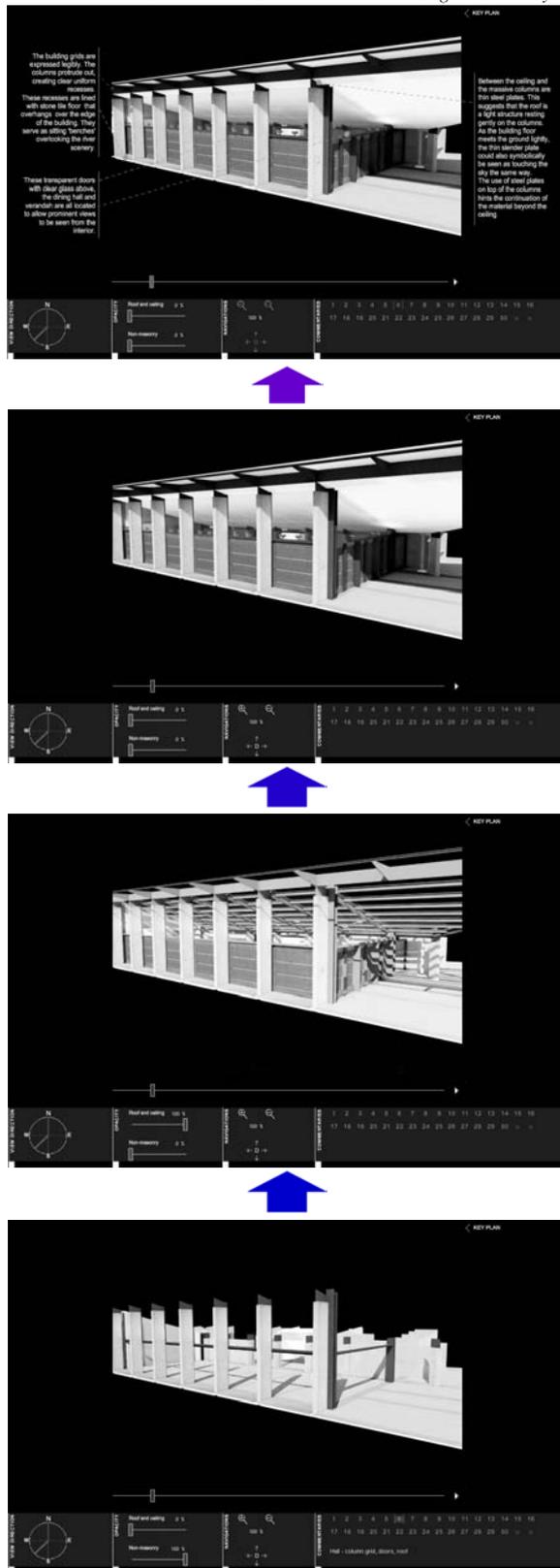
In the following example, pre-rendered walkthroughs/movies are selected due to:

- the need for focussed information dissemination to facilitate an organised mode of understanding the subject matter, and
- the manipulability and usability of pre-rendered movies in multiple computer platforms, hence facilitating wide accessibility.

Although not as significant as the above factors, another consideration is the quality of images. Even though pre-rendered images may be costly to produce, they take into account global illumination calculations which are still impossible to replicate in real-time digital environments at the time this paper is written. The high quality pre-rendered images therefore, present closer-to-factual data. For more comparative studies, please refer to [SSA01].

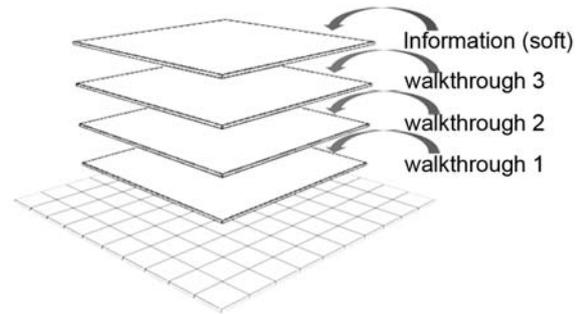
A walkthrough or flythrough should ideally attempt to clearly narrate both soft and hard information. One may argue that the narrative/information of a walkthrough will be influenced by the path that the 'camera' is set up to take. As Patrick Keller notes, the narration of an architectural animation sequence is determined by the sequence of visual stills, and not the other way around. "If one had put the pictures together in different order, or had shot different pictures, some other equally plausible fiction might have been the result" [Rat02]. The 'fiction' here can be regarded as narratives about the architecture. Any resulting walkthroughs/paths should be directed in a way that will impart crucial information, although this information will inevitably be selected and incomplete.

The main concern is whether the pre-rendered moving images might miss some important aspects of the building. But this is true with interactive VR environments as well. Most user-controlled VR environments situations lead users to an exercise that emphasizes searching for rather than understanding information; this is aptly illustrated by IRVE [BNC\*] - a project that investigates general ways of representing educational information in such an environment discounting discipline-specific requirements.



**Figure 3:** Screenshots: layering of multiple animations and information.

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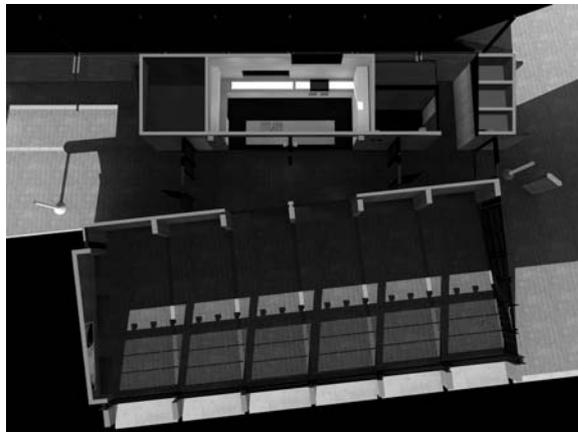
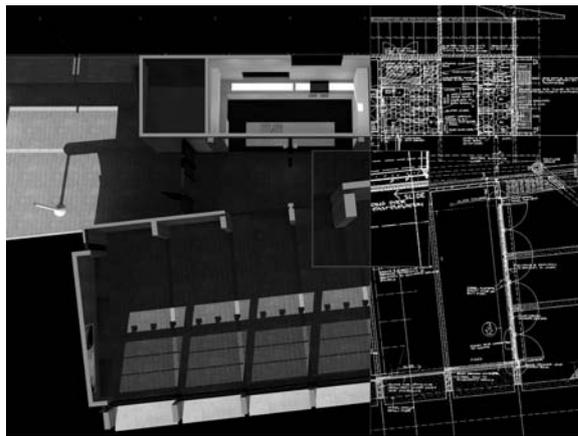
**Figure 4:** Stacked information in a walkthrough set with adjustable alpha channels.

To reduce the possibility of missing crucial information, it is often necessary that several sets of media are available to users, especially in larger scale buildings.

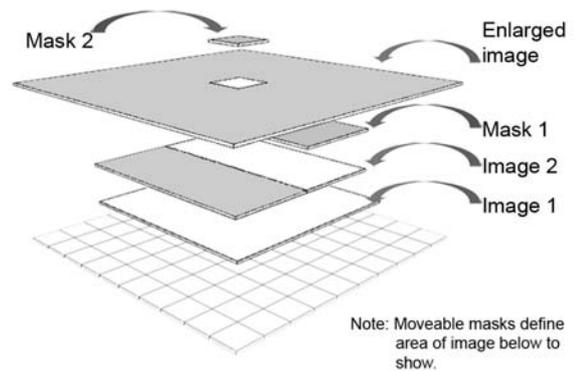
The nature of these moving pictures allows only a limited amount of information to be displayed at a time. Since they bear no true time-space constraint, they may be momentarily paused and relevant, often soft information about that particular scene can be displayed and read. Contextualizing more than one type of media within this also becomes possible. In order to take advantage of this, a separate information layer addresses the limitations of a movie length that might otherwise prevent the delivery of important in-depth narratives. The close interplay between texts and visuals in a visually-continuous environment is significant to contribute to a deeper understanding of the subject and thus helps reduce the level of misinterpretations.

### 8.2 Dynamic multi layering approach: Referencing to architectural documentation

Traditional sections, plans, and elevations exist in most architectural heritage documents. Possessing symbols and texts that work together well, this information is significant for an in-depth insight into the building composition. They serve as effective platforms to link textual media with graphics symbols to explain a building's construction materials, their locations/arrangements, sizes, etc. However, it does take trained individuals to translate them spatially. To those outside the field, the two-dimensional symbols and texts are hard to understand. Connecting them to rendered models which possess qualities of more decipherable visuals radically increases their legibility. The addition of a third dimension to the traditional two-dimensional drawings assists also in perceiving depth of structural components and spaces.



**Figure 5:** *Interplay of 2D and 3D information to arrive at an interactive, visual plan of hall with enlarged portion (in red-bounding box) for increased resolution/readability.*



**Figure 6:** *Stacked still images of close reference.*

Considerations need to be taken in reference to the legibility of the document during the digitisation process and the screen-size in which they are finally presented.

## 9. Conclusions

The power of architectural publications is often taken for granted and easily underestimated or overlooked in the quest for achieving an educational impact. This is exhibited in a compilation of articles in ‘Educating Architects’ where these publications’ presence and contributions have clearly not been acknowledged.[PT95] Digital delivery could alter this perception and augment the role of such publications to be an inseparable entity of architecture education.

More than the traditional publications, trends indicate that the public is leaning towards readily accessible electronic information when architectural information is concerned. As the internet-based survey results suggest, digital media are approaching and even surpassing printed media as a significant source of information. This is obviously a concern when currently the reliability and substance found in print media still exceed those of the widely accessible digital format.

The ideas presented in the model here are intended to promote interest in the capabilities of technologies in delivering architectural information. There are indeed myriads of features and information to be exploited in order to facilitate better understanding of architectural designs and especially those of high heritage values by extracting and expanding techniques from within the architectural field as well as from outside the industry. The examples proposed in this paper thus, are not meant to be the final and only solutions.

As hinted at by Paraizo [Par04], the possibility of visualisation techniques are limited only by the imagination and suitable use of ‘hyperdocumentation’; these techniques are of course, discipline-specific. In his digital visualisation of urban structure of Rio de Janeiro, Ripper Kós [1999] has adopted this hyperdocument approach of combining a se-

lection of still pictures to deliver the information of the city. Given the nature and details of architectural information, however, the execution and choice of media would unquestionably be different if it were to narrate the information of a building that exists within that urban fabric.

Some have observed that there has been no evaluation of the majority of proposed visualisation systems [RB05]. Others may also counter-argue that while there is an absence of valid, reliable testing instruments to start with, for approaches like those shown here to be a part of the future visualisation mainstream will realistically take more than a one-time validity testing to be successfully implemented. At present, technologies are still incessantly reconfigured and consequently, visualisation systems are likely to morph and improve. Thus, a 'validity' testing would prove age/time specific, while the data falling into the danger of being subscribed beyond their likely short expiry date. Due to this dependency on other factors, visualisation systems can/should not be deemed final or finalised by evaluated 'confirmation' at this point in time but considered as steps and influences towards better forms and facilitations.

That being said, the emergence of more effective common delivery modes for architectural information for the academics and the public at large is optimistically foreseeable as facilitating technologies further develop and perhaps plateau. Further studies of techniques of architectural information delivery and much experimentation need to work in tandem with available technologies both to take advantage of the opportunities and set the direction for a future seamless technological integration. Further convergence of those technologies overseen and capitalised by the content creators may indeed help better facilitate the understanding of architectural heritage, potential heritage and archaeological excavation projects.

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### References

- [AK05] AFFLECK J., KVAN T.: Reinterpreting Virtual Heritage *CAADRIA 2005 Proceedings of the 10th International Conference on Computer Aided Architectural Design Research in Asia*, New Delhi, India, vol. 1, (April 2005) pp. 169-178.  
[http://cumincad.scix.net/data/works/att/caadria2005\\_a\\_2\\_b\\_a.content.pdf](http://cumincad.scix.net/data/works/att/caadria2005_a_2_b_a.content.pdf).
- [BSS05] BERMUDEZ J., SMITH A. C., STRIEFEL S.: Visualizing the Invisible: Digital Studies on Representing Non-Visual Architectural Experiences, *CAADRIA 2005 Proceedings of the 10th International Conference on Computer Aided Architectural Design Research in Asia* New Delhi, India, vol. 2, (April 2005), pp. 510-515.  
[http://cumincad.scix.net/data/works/att/caadria2005\\_b\\_6\\_c\\_e.content.pdf](http://cumincad.scix.net/data/works/att/caadria2005_b_6_c_e.content.pdf).
- [BNC\*03] BOWMAN D. A., NORTH C., CHEN J., POLYS N. F., PYLA P. S., YILMAZ U.: Information-rich virtual environments: theory, tools, and research agenda, *2003 VRST* (October 2003), 81-90.  
<http://portal.acm.org/citation.cfm?doid=1008653.1008669>.
- [DPF03] DUMONT R., PELLACINI F., FERWERDA J. A., Perceptually-driven decision theory for interactive realistic rendering. *ACM Transactions on Graphics*, vol 22/2, (2003), pp 152-181.  
<http://portal.acm.org/citation.cfm?id=636888&coll=GUIDE&dl=GUIDE&CFID=112014&CFTOKEN=69813742>.
- [Fri00] FRIEDMAN A.: Language and Movement in CAD Application. *CAADRIA 2000 Proceedings of the Fifth Conference on Computer Aided Architectural Design Research in Asia*, Singapore, 18-19 (May 2000), pp. 423-432.  
<http://cumincad.scix.net/data/works/att/3cd1.content.pdf>.
- [Fro03] FROSH P., *The Image Factory*, (2003), pg 19-23.
- [FST92] FUNKHOUSER T. A., SÉQUIN C. H., TELLER S. J.: Management of large amounts of data in interactive building walkthroughs. *Proceedings of the 1992 symposium on Interactive 3D graphics*, (June 1992).  
<http://portal.acm.org/citation.cfm?id=147158&dl=ACM&coll=portal&CFID=15151515&CFTOKEN=6184618>.
- [Her05] HERITAGE OFFICE, *Assessing Heritage Significance*. New South Wales, 2001.  
[http://www.heritage.nsw.gov.au/03\\_index.htm](http://www.heritage.nsw.gov.au/03_index.htm).
- [HGS01] HYNST S., GERVAUTZ M., GRABNER M., SCHINDLER K.: A work-flow and data model for reconstruction, management, and visualization of archaeological sites. *Proceedings of the 2001 conference on Virtual reality, archaeology, and cultural heritage*, (2001), pp.43-52.  
<http://portal.acm.org/citation.cfm?id=585000&coll=GUIDE&dl=GUIDE&CFID=112014&CFTOKEN=69813742>.

- [Kou97] KOUTAMANIS A.: Digital Architectural Visualization. *Challenges of the Future: 15th Ecaade Conference Proceedings*, Vienna, Austria, (September 1997). pp.17-20.  
<http://cumincad.scix.net/data/works/att/cb26.content.pdf>.
- [KRB05] KWEE V., RADFORD A., BRUTON D. Hybrid Digital Media Architectural Visualisation Delivery -Murcutt, Lewin & Lark's The Arthur and Yvonne Boyd Education Centre on Digital Flatland. *International Journal of Architectural Computing*. Vol 3 (4), (Dec 2005) pp 487-502.
- [KRBR06-a] KWEE V., RADFORD A., BRUTON D. ROBERTS I.: *Architecture | Medial Representations: Survey Data 2006*. (2006)  
<http://cumincad.scix.net/cgi-bin/works/Show?8d88>.
- [KRBR06-b] KWEE V., RADFORD A., BRUTON D. *Architecture | Medial Representations: A Reassessment*. Paper to be presented at ANZAScA 2006, Adelaide, Australia, (22-25 Nov 2006).
- [Lev99] LEVINSON P.: *Digital McLuhan: A Guide to the Information Millennium*: New York: Routledge (1999). p.5.
- [Lus92] LUSCOMBE D. O., PEDEN A.: *Picturing Architecture: Graphic Presentation Techniques in Australian Architectural Practice*. Tortola, British Virgin Islands ; Roseville East, N.S.W: Craftsman House, (1992).
- [McI64] MCLUHAN M.: *Understanding Media : The Extensions of Man*. London: Routledge & Kegan Paul, 1964.
- [NHAH03] NIEDERAUER C., HOUSTON M., AGRAWALA M., HUMPHREYS G.: Non-invasive interactive visualization of dynamic architectural environments, *Proceedings of the 2003 symposium on Interactive 3D graphics*, (2003), pp55-58.  
<http://portal.acm.org/citation.cfm?id=882331&coll=GUIDE&dl=GUIDE&CFID=112014&CFTOKEN=69813742>.
- [Par04] PARAIZO R. C.: 2004. A representação do patrimônio urbano em hiperdocumentos: um estudo sobre o palácio monroe [The Representation of Urban Heritage in Hyperdocuments: A Study on the Monroe Palace], *SIGraDi 2004 - [Proceedings of the 8th Iberoamerican Congress of Digital Graphics]* Porte Alegre - Brasil (November 2004), 10-12.  
[http://cumincad.scix.net/data/works/att/sigradi2004\\_200.content.pdf](http://cumincad.scix.net/data/works/att/sigradi2004_200.content.pdf).
- [Pha04] *The Phaidon Atlas of Contemporary World Architecture*, Phaidon Press, London; New York, (2004), p.39.
- [PT95] PEARCE M., TOY M.: *Educating Architects*: London: Academy Editions, (1995).
- [Rat02] RATTENBURY K.: *This Is Not Architecture : Media Constructions*. London ; New York: Routledge, (2002). p.40.
- [RB05] RIPPER KÓS, J., BARKI, J.: Between text and hyper-text: a case in architectural theory, *SIGraDi 2005 - [Proceedings of the 9th Iberoamerican Congress of Digital Graphics]* Lima - Peru 21-24 (November 2005), vol. 2, pp. 788-792.
- [Rip03] RIPPER KÓS, J., (2003). *Rio-H [online]*  
<http://www.kos.med.br/thesis>.
- [Saa01] SASS L.: Reconstructing Palladio's Villas: A Computational Analysis of Palladio's Villa Design and Construction Process. In *Reinventing the Discourse - How Digital Tools Help Bridge and Transform Research, Education and Practice in Architecture. Proceedings of the Twenty First Annual Conference of the Association for Computer-Aided Design in Architecture*. Buffalo (New York) 11-14 (October 2001), pp. 212-226.  
<http://cumincad.scix.net/data/works/att/5166.content.pdf>.
- [SSA01] STAPPERS P. J., SAAKES D., ADRIAANSE J.: On the Narrative Structure of Virtual Reality Walkthroughs. An Analysis and Proposed Design. In *Proceedings of the Ninth International Conference on Computer aided Architectural Design Futures*, Eindhoven, 8-11 (July 2001), pp. 125-138.  
<http://cumincad.scix.net/data/works/att/3875.content.pdf>.
- [SWL04] SIU A. M. K., WAN A. S. K., LAU R. W. H., Modeling and Rendering of Walkthrough Environments with Panoramic Images. *Proceedings of the ACM symposium on Virtual reality software and technology* (2004), p 114-121.  
<http://portal.acm.org/citation.cfm?id=1077557&coll=GUIDE&dl=GUIDE&CFID=112014&CFTOKEN=69813742>.
- [WSBW01] WALD I., SLUSALLEK P.: BENTHIN C., WAGNER M.: *Interactive Rendering with Coherent Ray Tracing*. EUROGRAPHICS (2001), vol 20-3.  
<http://www.eg.org/EG/CGF/volume20/issue3/508.pdf>.
- [YC03] YANG L., CRAWFIS R.: Panoramic Walkthrough System with Occlusion Culling, *Proceedings of the workshop on Virtual environments* (2003), pp 169-177.  
<http://portal.acm.org/citation.cfm?id=769973&coll=GUIDE&dl=GUIDE&CFID=112014&CFTOKEN=69813742>.

